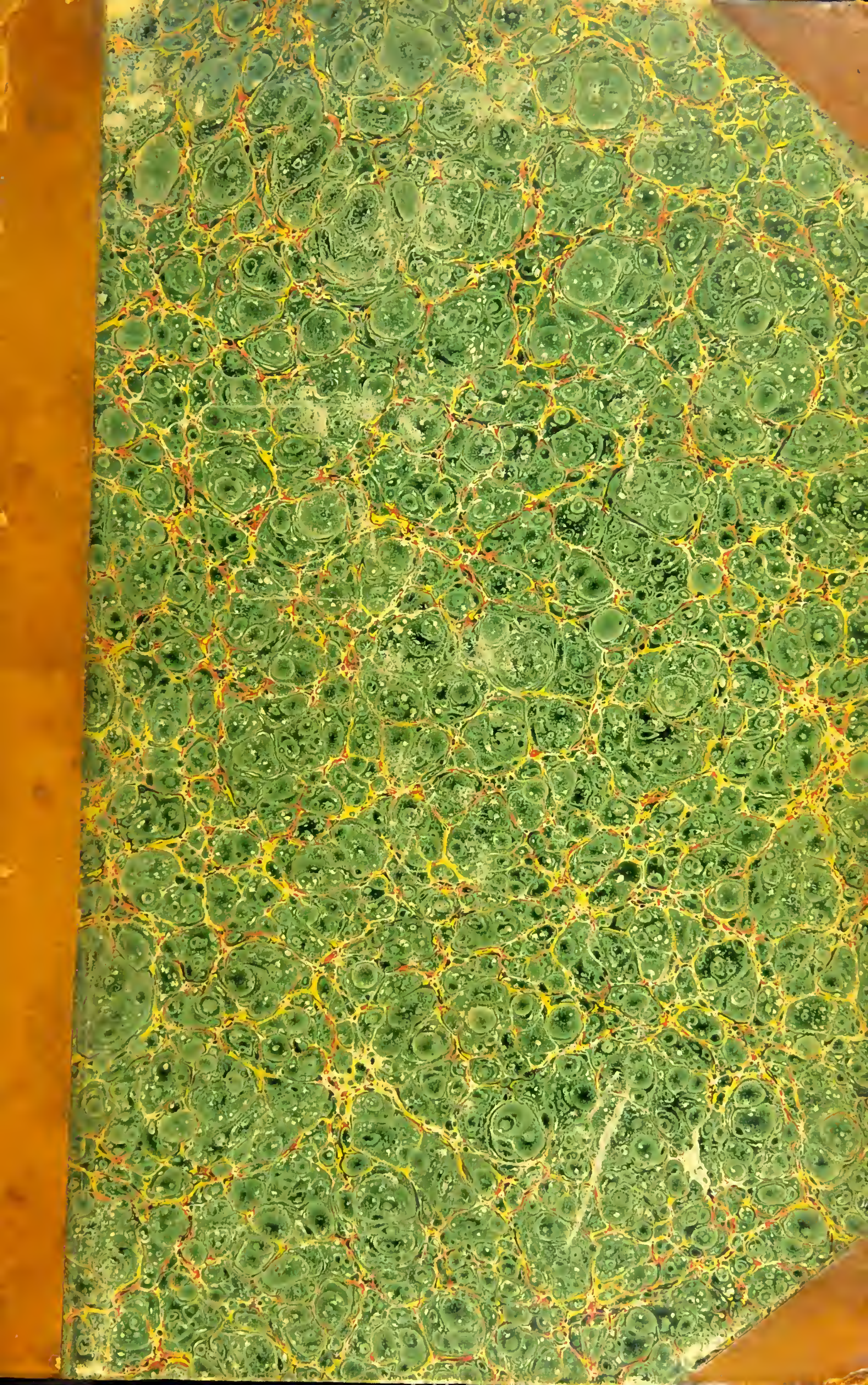

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LECTURES

ON

ANATOMY:

INTERSPERSED WITH PRACTICAL REMARKS.

VOL. III.

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&c. &c. &c.

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INTRODUCTION.

In pursuance of the general plan of my Lectures, this Volume will be found to contain that portion of the anatomy of the human body, which is more particularly connected with physiology.

Some apology may be necessary for the extent to which I have entered upon physiological subjects in a work professedly anatomical; but as my object is to embody a complete system of anatomy, in connection with physiology and surgery, I have considered it my duty to pay more particular attention to the many important discoveries which have of late years been made, and are still in progress; in order that the student may be so far interested, as to lead him to seek the fullest information, in the numerous works now before the public, on the valuable and interesting science of physiology.

London; October, 1831.

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LECTURES ON ANATOMY.

PART VI.

GENERAL ANATOMY OF THE MUCOUS MEMBRANES, &c.

LECTURE XXII.

GENERAL ANATOMY OF THE MUCOUS MEMBRANES.

In the first and second volumes of my Lectures on Anatomy, I have treated of the bones, ligaments, muscles, and those structures which form the exterior of the human body; I shall now proceed with the anatomy of the internal cavities, and their contents.

The *mucous membranes* form an interior lining to all the cavities and glandular structures, which either directly or indirectly have a communication with the atmospheric air. The consideration of these membranes, therefore, seems properly to follow that of the external integuments; not only on account of their actual continuation or prolongation from them, but from their being alike destined to protect the parts which they cover from the injuries of external agents.

From these circumstances the mucous membranes have been termed the internal tegumentary system, and, as we shall hereafter have occasion to observe, they possess many characters in common with the external integuments. Indeed, in an anatomical point of view, a close alliance has been admitted, ever since the time of Galen. Meckel classes them as the external and internal cutaneous systems; Beclard terms them both tegumentary membranes; while Blainville speaks of them under the general appellation of envelope or covering: from whence we may learn, that however they are classed, the characters which they present in common, form a very prominent feature.

These membranes are the organs of some of the most important functions of life, and equally in a physiological and pathological point of view, an accurate knowledge of them is of the greatest moment to the medical, as well as the anatomical student. It is on the mucous membranes that external agents first act; in them resides that undiscovered vital power which effects the great chemical changes that are exerted in the processes of digestion, absorption, and excretion; and to them also are applied our therapeutical agents.

The term mucous membrane, was taken originally from the viscid secretion of the schneiderian membrane of the nose; but it is now extended to the various linings of the digestive, pulmonary, urinary, and genital organs, together with those glandular structures which have excretory ducts communicating with them. To these are also added the tunicæ conjunctivæ, and excretories of the lacrymal glands, the membranes lining the cavities leading from the mouth and fauces to the ear, and sinuses of the bones of the skull.

Bishat has classed the mucous membranes in two great divisions or surfaces,—the gastro-pulmonary, and the genito-urinary,

The *gastro-pulmonary*—commences with the tunicæ conjunctivæ, at their point of contact with the external integuments on the edges of the eyelids; two processes extend from each tunica conjunctiva,—one along the duct of the lacrymal gland, the other through the puncta lacrymalia, the lacrymal sac and duct, to its junction with the schneiderian membrane of the nose; it then lines the nasal cavities communicating with the external skin at the anterior openings of the nostrils; while upwards it sends portions which are continued into the sinuses within the bones of the cranium, and backwards it is continued into the fauces, pharynx and mouth; from the mouth processes are sent to the parotid, submaxillary and sublingual ducts; from the pharynx prolongations extend from the eustachian tubes to the cavities of the tympana and mastoid cells; while in the back and lower part of the pharynx it divides into two principal portions, the anterior of which passes through the larynx, trachæa and bronchia, to their ultimate distributions; while the posterior passes down the œsophagus to the stomach and remaining portion of the alimentary canal, terminating at its junction with the external integuments at the anus. In the alimentary canal it gives off two processes, the one to the ductus communis choledochus, proceeding from thence to the ductus hepaticus, ductus cysticus and gall bladder; the other to the ductus pancreaticus. This completes the gastro-pulmonary division.

The *genito-urinary* division—commences at the orifice of the urethra, continues along it to the bladder, giving off processes in its passage to Cowper's gland, the prostate gland, vesiculæ seminales, vasa deferentia, and their ramifications within the testes. From the bladder two processes proceed along the ureters to the pelves, infundibula, mammillary processes, and probably to the uriniferous tubes of the kidneys.

In the female, this division of the mucous membrane continues, as in the male, to the bladder and urinary organs, but necessarily offers many differences in the genital organs, in which it lines, first, the vulva, then the vagina, uterus, fallopean tubes, and at their fimbriated extremities are supposed to open into the serous cavity of the broad ligaments.

In the female there is a distinct mucous membrane, which belongs to the mammæ, extending from the nipples along the lactiferous tubes to their ultimate division.

In the examination of the mucous membranes and their secretions, we shall find that they present a variety every where commensurate with the function of the organ with which they are connected; and so great is this variety, that one function cannot be considered, in the remotest degree, to depend upon their actual continuity with each other, or with the common integuments.

The appearance of the mucous secretions, as well as their qualities, are widely different in the different organs, even although they are continuous and situated near to each other; as, for instance, the secretion of the schneiderian membrane and the tunicæ conjunctivæ; and again, between the secretion of either of these membranes and that which is found in the tympanum, mastoid cells and sinuses, where it is rather of an oily than a mucous nature; these latter cavities in a healthy state are filled with air, and mucous secretion is not traceable beyond the canal of the eustachian tube, either in man, or other animals possessing such structures. From this fact, as well as from the appearance of the interior of these cavities, there is reason to doubt whether or not mucous membrane does enter them; particularly as such a secretion would probably interfere with the sense of hearing. It may further be remarked, that in certain species of the reptile tribe the tunicæ conjunctivæ are detached from the gastro-pulmonary mucous surface; and in certain fishes, the membrane lining the nasal organs is also detached.

Those writers who insist upon the identity of the mucous membranes with the common integuments, have endeavoured to support their theories, by adducing certain analogies which are found to exist between the inferior orders of animals and the embryo state of the human fœtus. These analogies are traced in the changes which are asserted to take place in the progress of the growth of the fœtus, and are compared with a similar, though permanent, existence in different animals. There is, however, a very wide difference between analogies and real identity; and mere analogy not unfrequently proves a source of delusion, obscuring the simplicity of truth, which can alone be established on the firm basis of demonstrable fact. The circumstances here alluded to, and particularly dwelt upon by Blainville, are however extremely interesting; inasmuch as they shew the extensive power resident in membranous structures: the reader must, however, follow his own judgment in admitting the deductions of the above-named ingenious author. He commences with instances of the general envelope of living bodies in their simplest form; as in the zoophite, where one external surface, in contact with the fluid in which the animal exists, appears to serve all the purposes of nutrition, respiration, and generation. Proceeding in the scale of animal perfection, the polypus presents not only an external surface, but an inverted or internal cavity, having but one orifice leading into it; this orifice serves the double purpose of mouth and anus, and, as may be seen through the medium of a good solar microscope, both the food and the young animals are ejected by one and the same effort of contraction. In the next stage of perfection, we observe this internal cavity furnished with two openings, the intermediate space being more or less lengthened into the form of a canal,—the continuity with the external surface still remaining unbroken. As we ascend the scale, we find the same internal cavity performing separate and distinct functions, being divided into numerous portions, each appropriated to separate offices. Thus the respiration becomes a distinct function from generation, and digestion is performed by organs separate from either one of them: at the same time, the membranes which compose these external and internal surfaces become more complicated in their structure, not only in certain distinct layers of which they are composed, but in the number of follicular, papillary, and glandular formations superadded to them.

The above scale of existence is compared with the human embryo, which, during its earliest state, is supposed to consist entirely of skin and mucous membrane. The anterior part of the body and the intestinal canal are at this period open, and form a perfect continuity. The skin afterwards closes, the junction being made apparent in the existence of the mesian line of the body; at the same time the walls of the intestines unite to complete the alimentary canal: at this period, also, the mucous membranes are thinner, and more simple in their structure. Towards the sixth month, the valvulæ conniventes and convolutions make their first appearance in the intestines; while the sebaceous glands are abundantly developed in the common integuments. The surface of the fœtal body is now defended by an oily secretion, which protects it from the liquor amnii, otherwise perhaps destructive to the cuticle, which is destined for the future contact of the atmospheric air. In the intestines, also, a mucous secretion of a viscid quality is formed; at first it is of a whitish color, but afterwards it is changed to a dark green, as is seen in those discharges from the rectum after birth, known by the name of the meconium.

It seems most probable, that these substances are in the first instance a secretion from the sebaceous follicles, and in the latter from the mucous membranes of the alimentary canal.

The analogies between the mucous and integumentary systems are, however, supported by the circumstances, that they both present one free and one attached surface; in other words, they are both distributed on the surfaces of other structures, forming together one unbroken connection. Their free surfaces are uneven, and furnished with superadded structures, in which they differ from the serous membranes. The most remarkable fact denoting the similarity which exists between them, is in the reciprocal convertibility of their surfaces in particular situations. Thus, when a part of the mucous membrane becomes constantly exposed to the drying effects of the atmospheric air, as occurs in certain cases of artificial anus, or of prolapsus uteri and ani, it will gradually acquire the properties of external integument, and will be covered by a cuticle and rete mucosum; on the other hand, when a part usually covered with external integument is defended from the effects of the air, in consequence of continued pressure, and is at the same time in a state of moisture from the perspiration of the part, as in certain cases of permanent contractions of joints, &c., such parts will acquire the properties of mucous surfaces. There is therefore, undoubtedly, a close alliance between these membranes; but nothing in that alliance to establish their identity. The nervous system, in its various distribution, presents a much closer alliance; but who has ever endeavoured to prove that the eye is derived, by continuity, from the ear; or the sense of taste in the mouth, from the sense of touch in the skin? On the contrary, do not all these structures, so various in their properties and functions, prove that they are endowed exactly with those qualities, and no others, which are alone subservient to the functions they are each destined to perform?

Physical Properties and Anatomical Structure of the Mucous Membranes.

The mucous membranes are composed of a dense cellular tissue, having two surfaces,—one free, and the other attached to the organs with which they are respectively connected. Their tissue is not areolated, as in the common integuments, but is more fibrous; and in certain instances, as in the petuitary membrane, it is of a spongy or fungous structure. The ancients described the basis of the mucous membrane as an expansion of a nervous nature, giving it the name of *tunica nervea.* This substance in situation answers to the cutis vera, and in certain instances, as along the œsophagus, is furnished with a cuticular covering; while in others a viscid mucous secretion appears to be a mean of protection against the injuries of external agents. The free surface of the mucous membranes is composed of innumerable villi and papillæ, interspersed with follicular and glandular appendages, hereafter to be described, and which are more or less abundant in different situations. These appendages have received various names; such as the villous, fungous, porous, villoso-papillary, and the petuitary membranes.

The color of the mucous membranes varies from a pale yellow to a deep red or brown, and frequently they are of a mottled appearance; depending partly on the quantity of blood circulating, and partly on the coloring matter natural to them. Their density is less than that of the common integuments, but is greater than that of the cellular tissue.

Their extensibility and flexibility is considerable, more particularly in the hollow viscera, the stomach, intestines, and urinary bladder. In these, however, great power of extension is to be attributed to the unfolding of the rugæ which exist in the collapsed state of those viscera.

Their contractibility or tone is very great, and exceeds that of the common integuments. In certain situations, as in the mouth, this power is exerted with great rapidity; while in others, as in the uterus after parturition, it is slower and more gradual.

Their irritability is a matter of controversy; and although admitted by some anatomists, it is doubtful whether or not this power resides in the mucous membranes themselves, independent of the subjacent muscular structures. Stimulants have been variously applied to them in the living animal, without evincing any power of contraction.

Their sensibility is exquisite, particularly in the nose, tongue, tunica conjunctiva, glans penis, urethra and vagina; for the most part, however, there is an obscure sensibility not readily perceived by the mind. To this sensibility we must refer the sense of hunger, thirst, repletion, &c.; the sensations caused by the retention of the urine and fæces; and no doubt all the phenomena attendant on the progress of parturition, and which generally commence when the uterus has attained a certain degree of distention. Excepting in the situations above named, there does not appear to be an abundant supply of nerves distributed to the mucous membranes; which is more remarkable, on account of the high degree of vital activity possessed by them. This feeble state of sensation is particularly apparent in the œsophagus, through which fluids of a high temperature will pass, and be lodged in the stomach without producing an uneasy sensation; while other fluids may be possessed of such acrid qualities, that their presence in the mouth, or even upon the common integuments, would be attended with most sensible pain. Excepting the particular senses, the nerves distributed to the mucous membranes are derived principally from the great sympathetic and pneumo gastric nerves; at all the natural openings of the intestinal canal, the nerves proceed from the brain and spinal marrow.

The mucous membranes, in certain situations, are abundantly supplied with blood-vessels and lymphatics, subdivided into the most minute ramifications, and for the most part constituting a capillary system of circulation. All the mucous membranes are by no means similarly circumstanced in this respect; and there is likewise a remarkable difference in the quantity of blood which the same membrane receives at different times, as, for instance, in cases of asphyxia and syncope, when they become loaded.

Haller, and some other physiologists, have asserted, that the whole mucous system is furnished with an epidermis; these assertions appear to have no other support, than the presence of certain layers of lymph which form during an inflamed state, and which have been mistaken for cuticular separations. The epidermis may be traced along the œsophagus, as far as its junction with the stomach, It is again very apparent in the vagina, but is lost at the orifice of the uterus; it is found at the orifices of the intestinal canal, from whence it becomes gradually imperceptible.

Of the Appendages or Parts superadded to the Mucous Structures.

These consist of villi, follicles, papillæ, and mucous glands. Blainville has classed the superadded parts of the whole tegumentary system under two heads. The first, comprising all the modifications of follicles or crypts, from the Greek word κρυπτω, to *hide* or *conceal;* the second, phanere, from the word φανερος, *evident* or *manifest.* We have here to speak of the follicles or crypts, so abundantly supplied to the mucous membranes. They are situated within the substance of the membranes, having open mouths upon their surfaces. They are composed of an external fibrous covering, having two openings,—one internal, for the passage of vessels and nerves, which are necessary for its function; the other sometimes produced in the form of a canal, for the exit of the produce of its secretion. Within this fibrous tunic, adherent to its internal surface, is a second tunic, of a very vascular construction. This is filled with a fluid which, after being retained for a certain period, appears to obtain a more viscid or inspissated consistence, and is ejected by the external orifice to perform its particular uses. These uses are various; in the stomach and intestines it is of a solvent quality, resembling a chemical action, and is subservient to the process of digestion: in the mouth it is of a solvent and various quality; in the nose viscid, forming a protection to the sentient nerves of smell; it is also spread over surfaces to protect them by mucous or greasy secretions: upon the whole, however, these secretions are of a mucous nature. In the intestines the animal differs from the vegetable mucus, in possessing a larger proportion of azote. When in a liquid and pure state, mucus is of a transparent white color; in this state specimens have been obtained from the gall bladder when the ductus cysticus has been long obstructed; the mucus so collected is as transparent as rock crystal; and although possessing a considerable degree of fluidity, it has such a degree of tenacity, that it may be drawn out in threads like melted glass. Although this is the state of mucus under the above circumstances, and it may be considered as a pretty uniform production of the animal system; yet its appearance varies, from numerous sources of admixture in the different membranes. In the bladder and urinary passages, in their healthy state, only such a quantity appears to be secreted as is necessary to defend them from the acrimony of their proper secretions, and in them its presence is rarely perceptible, excepting in a state of disease. From the compound nature of the mucous membranes, and their complicated secreting appendages, it is by no means easy to determine how much of the quantity and quality of their secretions is to be attributed to the membranes themselves, and how much to their appendages. In the mouth, fauces and intestines, and particularly at the os tincæ, it is evident that mucus is the product of the follicular apparatus; yet the presence of a quantity of mucus in situations not abundantly supplied with follicles, leave no room to doubt that the membranes, as well as their follicles, are capable of producing it.

Anatomical investigation has not yet enabled us to point out a variety of structure corresponding to these various powers resident in the mucous membranes. It is obvious, that considerable variety must be met with in the analysis of mucus, from various situations; Berzelius gives the following analysis of mucus, taken from the nose and bronchia:—

Water	933 ·9
Mucous matter	53 ·3
Hydrochlorate of potash and soda	5 ·6
Lactate (acetate) of soda and animal matter	3 ·0
Soda	0 ·9
Phosphate of soda, albumen, and animal matter	3 ·3
	1000 ·0

It is soluble in water, and in dilute sulphuric acid; it is not coagulable by heat, nor precipitated by corrosive sublimate; as an animal compound, it forms one of the immediate principles of organization.

The general classification by Blainville of the appendages of the integumentary membranes into crypts and phanere, and the structure of the former above alluded to, is too superficial when compared with the varieties presented in the villi, papillæ, and glandular follicles attached to the mucous membranes. Of these we shall now give a more particular description.

The villi, compared to the pile of velvet, are very generally distributed on the inner or free surface of the mucous membranes; they are extremely small, being only about one-fourth of a line in length, and usually require the aid of a lens to be seen distinctly. Their size varies in different situations: they are larger and thicker on the upper portion of the small intestines, than on the lower part; less in the stomach; less in the large intestines and bladder; and are scarcely, if at all perceptible, in the sinuses of the head. Meckel has enumerated about four thousand of them upon one square inch of intestine. According to Beclard, their form is that of laminæ, or leaves, variously disposed in the stomach, jejunum, colon, &c.; while by other anatomists they have been described as conical, cylindrical and tube-like. From injections it is apparent that they have an abundant circulation of blood-vessels. The veins are also numerous, and have an erectile disposition. The absorbents, according to Cruickshank, are numerous, and terminate in open mouths; from fifteen to twenty of which he counted on a single villus of the jejunum.

Other anatomists assert, that the villi consist of a spongy gelatinous substance, which is the seat of absorption; and deny that the chyliferous vessels have open mouths; whence it may be concluded, that the subject is still involved in obscurity. Nerves have not been traced to the villi, although there can be but little doubt that they possess them abundantly.

The next kind of appendage we shall notice, is the papillæ, so named from their resemblance to small nipples. These are more distinct than the villi, particularly on the dorsum of the tongue, where they may be seen with the naked eye. Four classes have been enumerated, distinguished by their various forms: they are the filiform, the conical, the fungiform, and the lenticular or truncated. They have also been distinguished by their various sizes into papillæ majores, mediæ, and minimæ. They are formed of a delicate cellular tissue, on the surface of which is distributed an abundant circulating medium. Nervous filaments have been traced to them in the tongue, nostrils and glans penis.

The follicles or mucous glands, are the next species of appendage, and which particularly characterise these membranes; their minute anatomy, as given by Blainville, we have already alluded to; but there are other circumstances regarding them worthy of notice. Excepting the opening mentioned by Blainville for the passage of nerves and vessels, these membranes are in the form of a *cul de sac*, varying in shape, number and size, in different situations. They are round or oval, infundibular or lenticular. They are most numerous in the palate, bronchia, œsophagus, and intestinal canal. They have obtained various names: the smallest have been termed the cryptæ minimæ, and are pretty equally dispersed; in the duodenum they are larger, and are placed in an isolated order,—hence termed glandulæ solitariæ; while in the ileum they are formed in clusters, termed the glandulæ aggregatæ. When several are united, they have the appearance of proper glands: in which class certain anatomists place the tonsils, glands of Cowper, and even the prostate. Those follicles which have large mouths, are known by the name of lacunæ, as in the urethra and rectum, &c.

La Vagna, Walter, Bonn and Blainville, have classed the teeth among the appendages of the mucous membranes; their obvious bony structure, and characters, do not bear sufficient analogy to these membranes to induce me to describe them separate from other bony structures.

Pathological View of the Mucous Membranes.

The mucous membranes are the seats of a great variety of diseases, which bear a certain resemblance to each other in their general character; although varied according to the different situations and functions of individual parts. Of these diseases the greater number fall more immediately under the care of the physician than of the surgeon; the knowledge of them is however of great importance, on account of the extensive variety of morbid appearances connected with them; and which the surgeon is constantly called upon to characterize and describe in *post mortem* examinations: for which reason, I shall give a more lengthened detail of the diseases incident to mucous membranes, than otherwise would be consistent with a work on anatomy.

The mucous membranes are constantly liable to inflammation, from various causes. Their general appearance, in an inflamed state, is that of a deeply reddened surface, in consequence of the infinite multitude of minute vessels suffused with blood. This surface, so reddened, will be spotted with minute points of a still deeper color, so uniform as to resemble small patches in which ecchymosis has taken place. In this state, the inflammation may exist in the mucous membrane itself, without extending to the subjacent tissues; but when intense, and of long continuance, the mucous membranes will become thickened, their secretions altered, and a variety of appearances will arise, among which the following are most prominent:—the membrane will become softer in its texture, so as easily to be torn by the pressure of the finger; the surface will become irregular, assuming a granular appearance, not unlike a healing ulcer. These appearances are often seen on the tunica conjunctiva, during the progress of purulent opthalmia, and in the alimentary canal, more frequently in the larger intestines in cases of severe dysentery; they may also be seen in cases of bronchitis. Such appearances occasionally assume an inordinate elevation, when they have been termed caruncles or granulæ, as on the inner surface of the eyelids, and in the colon. When inflammation has proceeded to these morbid productions in the mucous membranes, their secretions have generally become puriform; at first, their secretion may either be entirely stopped, or abundantly increased in quantity and fluidity, being much less viscid than usual; or it may be more firm, and not so readily dissolved in other fluids. The abundant watery secretion which often accompanies it will become charged with salts, and will be extremely irritating and acrimonious; from this state the secretion may assume its natural character, as it gradually returns to health; but, on the contrary, the secretion may change to a puriform consistence, which continuing, will terminate in an ulcerated process. To ascertain the nature of a secretion of pus, or mucus, observations have been made with an instrument called an Eriometer. It consists of two slips of glass; a drop of fluid is placed between them, which will be found on pressing the pieces of glass, to refract light in different degrees, according to the consistence or structure of the fluid submitted. Thus true pus is ascertained by the globules which it contains refracting light in concentric rings; while mucus, being destitute of globules, will not present these appearances.

Ulcerations of a character peculiar to the mucous membranes, commence in numerous points, producing small vesicles; these have a close relation to aphtha. This vesicular form of ulceration has been supposed to depend on the presence of an epidermoidal covering, its progress having been observed in all its stages only in the mouth, where the epidermis is to be traced. Sometimes the edges of ulcerations will be much thickened, irregular, and of a bright florid color, particularly when in the intestines; in this state the subjacent structures appear to participate in the disease. Another form of ulceration peculiar to the mucous membranes appears in numerous spots, and seldom occupies any extent of surface; the edges of these ulcerations are not elevated or thickened, or accompanied by an evident increase of vascularity or alteration of color: ulcerations of this description are met with in the trachæa and alimentary canal. Ulcerations will also arise from the deranged state into which these membranes will be thrown, in consequence of the complete suppression of their secretions; instances of which are met with in the nose, fauces, and particularly in the small intestines. The mucous membranes are particularly liable to chronic inflammations, perhaps more so than any other structure in the human body. In such cases, the mucus is either thicker or more viscid, or it assumes a purulent consistence: of such a nature are those discharges called gleety, and blennorhœal. The membranes are uneven or granular, thickened, and often more dense than in acute inflammation. Their tenacity is, however, less than in health, and they are not easily detached from their subjacent parts, being readily lacerated. Their vascularity, in some instances, is much increased; but in others, the parts affected will be unusually pale, or of a brown, grey, or black color. The latter color, may however arise from the presence of carbonaceous matter, and may not indicate a chronic affection.

Great difference of opinion has arisen respecting the reproduction of mucous membrane, in situations where it has been partially destroyed. Like the common integuments, the mucous membranes may maintain an ulcerative process, which shall only destroy their exterior surface, and which will be completely restored in the process of reparation; but if the ulcer produces a total destruction of the whole thickness of the membrane, a cicatrix is the consequence, in the mucous membranes as in the common integuments. Such restored surfaces bear but a mutilated character, and the mucus yielded from them is as dissimilar from natural mucus, as an external cicatrix is from perfect skin. As in the external integuments mucous membranes are restored by granulations proceeding from the edges of the healing ulcers; so also, as in the skin, the new cicatrices of the mucous membranes exhibit a strong tendency to contract; this is seen in the production of strictures in the urethra, and rectum; this power of contraction is also occasionally seen in the fauces, after deep and extensive ulcerations.

The various mucous membranes are the seats of certain specific diseases, or poisonous affections; thus the urethra, and tunica conjunctiva, are particularly liable to the infection of gonnorrhœa; the nose and throat, to syphilis; scarlatina affects the throat, as well as the common integuments; measles will affect the upper part, or even the whole course of the bronchial tubes; hydrophobia the larynx, the pharynx, and the stomach; arsenic the stomach, and rectum; and cantharides, the bladder.

Gangrene affects the mucous membranes, in consequence of a very high degree of inflammation; as is seen in the intestines, and more frequently in the throat: in other instances, it occurs from deficiency of nutrition, as in certain cases of colica, where the muscular coats are subject to violent action. In cases of strangulated hernia, introsusception, removal of a prolapsed uterus, or of a polypus by ligature, the mucous membrane dies with the subjacent parts, and undergoes the usual processes of ulcerative separation.

The mucous membranes are subject to a change in their tenacity, and become completely softened. This occurs generally in the gastro-intestinal mucous membrane, and more particularly in that portion of it lining the stomach. Various causes have been assigned as the origin of this morbid state; it is not improbably closely allied to those cases of gangrene, already alluded to as being produced from a defect of nutrition, and is by many considered to arise from a chronic inflammation of the sub-mucous cellular tissue, which occasions a defective circulation in the mucous membranes themselves.

Some few cases have been recorded of ossification in the mucous membranes; these are rare, and have been met with only in the uterus, and in the gall bladder. Their conversion into cartilage, has also been recorded to have taken place in the œsophagus, and in the lungs; in the latter situation, however, the cases mentioned by Beclard appear rather to depend on those morbid changes connected with tubercles, than on the changes in the mucous membranes themselves.

In common with most other structures of the body, the mucous membranes are liable to fungus hæmatodes. This disease arises much more frequently in the sub-mucous cellular tissue, than in the mucous membranes themselves; when in the latter, it assumes the form of cysts, hanging in clusters from short peduncles. In some instances, several pedunculated bodies are attached to one common peduncle, in others from a larger cyst partly enclosing them: these occur in the urinary bladder, and in the trachea. In other instances, this disease assumes the form of warty fungus of the skin. It has been supposed, that from the nature of the cavities in which these malignant diseases occur, their growth is more rapid, not being impeded by pressure, as in structures of greater solidity.

In diseases, particularly of the lungs, the liver, and the heart, the mucous membranes are often found in a state of congestion; in which the veins are more particularly filled with blood, presenting a cadaverous hue, which has often been mistaken for inflammation. It is not improbable, that this state is frequently produced by the last efforts of expiring life, which are unable to carry on the current of blood beyond the arterial influence. The mode of death, as well as the particular situation in which these appearances are found;—the congestion being most abundant in the veins, and being more equally diffused than in inflammation; the membrane being neither indurated nor softened, and the secretion on its surface being little, if at all altered from a natural state;—form the best criteria to guide our judgment in these cases.

Bichat has recommended the dissection of living animals, in order to gain a correct knowledge of the appearances of the mucous membranes, before and after death.

The follicles are frequently the seat of disease; they may either be simply enlarged, or, retaining their contents, form tumours; such cases are met with occasionally in the labial glands. The mucous membrane surrounding a follicle will frequently take on inflammation, in consequence of irritation commencing in the follicle itself; in this state they either swell, forming an elevation, or they present an areola of increased vascularity, which terminates in an ulcerative process; more particularly apparent when the follicles are situated in clusters. Not unfrequently malignant ulcers arise in these structures, as in the lips, the anus, and the os uteri.

Emphysema occurs in the sub-mucous cellular tissue, and has been met with under the mucous membrane of the stomach, intestines, and biliary ducts.

Œdema also frequently occurs in the sub-mucous cellular tissue, and when in the epiglottis and chordæ vocales, often proves fatal. Œdema is sometimes occasioned by disease of the heart, of the liver, and by chronic peritonitis.

Inflammation of the sub-mucous cellular tissue may exist, accompanying that of the membrane itself; and instances are mentioned by Andral, in his paper on chronic gastritis, of its continuance in this structure after it has subsided in the mucous membrane.

The sub-mucous cellular membrane is sometimes filled with an infiltration of pus; this has been met with in the air passages, and in the alimentary canal, and occasionally in small isolated patches in the small intestines.

In other instances, an effusion of a more plastic character occurs, which gives rise to contractions, as in the hourglass contraction of the stomach, contractions of the canal, of the œsophagus, urethra, and intestines.

The sub-mucous cellular tissue is also the seat of fatty tumours, membranous cysts containing hair, teeth, and fat, and those tumours of minute vessels termed erectile tissue; of this latter character, are certain forms of hemorrhoids. This tissue is also liable to all the forms of disease which have been termed malignant, which often make considerable progress before the mucous membranes themselves become affected. As these diseases advance, the membranes become remarkably softened, give way, and ulcerate; presenting, however, a somewhat different character from that which commences in the membrane itself. As connected with the mucous membranes, it may here also be proper to mention, that the muscular structure beneath them, partakes of disease in consequence of their derangement; and will be remarkably thickened, as is seen in the bladder, pylorus, stomach, and urethra, in consequence of strictures, or the progress of malignant diseases.

GENERAL ANATOMY OF THE SEROUS MEMBRANES.

In continuation of this subject, the serous membranes next claim our attention. These structures, like the mucous membranes, are distributed upon the surfaces of those organs with which they are connected: and, like them, present one attached, and another free secreting surface; but, unlike the mucous membranes, they form closed sacs, having no communication with the atmospheric air.

These membranes form a very extensive secreting surface, and are termed serous, in consequence of the numerous vessels they contain, and from the peculiar fluid with which they are always found to be moistened bearing great resemblance to the serum of the blood.

They are found in different situations in the body, and may be divided into those which line the interior of cavities, giving a covering to the viscera within them; into those which form synovial sacs, and which are connected with the articulations and tendons; and into such as are placed immediately under the skin. With but one exception, all the serous membranes form closed sacs or bags, without presenting an opening into any other structure; so that their secretion is entirely isolated. The exception to this arrangement is found in the instance of the fallopian tube opening into the peritoneal cavity in the female.

The form of the serous bags differ very materially in different parts of the body; sometimes presenting small rounded sacs, at others, running for a considerable distance along tendons, and dividing into numerous processes in blind pouches; and again, as is seen in the splanchnic serous membranes, they so closely cover certain viscera as more or less to resemble in figure the organ to which they are attached; or they may form so many prolongations between the different viscera, as to render it impossible to describe their peculiar configuration: but it is to be remembered, that, as all the viscera which are covered by these membranes are external to their secreting cavities, the membrane is always reflected from one viscus to another as a double membrane, and that the connecting and intervening processes must necessarily maintain their internal cavities.

The serous membranes not being of the same structure as the organs which they connect and enclose, form one of the best distinguishing marks of separation of one organ from another.

There are certain differences in the character of the two surfaces of all the serous membranes. An *external* one which is rough, or rather cellular, and is connected with more or less firmness either to ligaments, tendons, cartilages, or some of the viscera contained within the cavities of the body. The *internal* one, termed the free surface of the membrane, is smooth, polished, and moist; but, however, if examined through a microscope, it may be said to present somewhat the appearance of villosities, but which appearance seems rather to depend upon the whole membrane being thrown into folds, than upon any doubling of its internal surface.

The splanchnic serous membranes sometimes form such reflections as to produce two sacs, one within the other, as may be observed in the reflected portion of the peritoneum, termed the omentum.

The organization of the serous membranes very much resembles that of the cellular tissue, presenting a homogeneous surface in their texture, without any appearance of fibres; and are only to be distinguished from the cellular membrane by their being more of a condensed nature, by forming distinct cavities, and being somewhat transparent and brilliant. Some of the serous membranes are so similar to the cellular tissue, as scarcely to be distinguished.

The blood-vessels of the serous membranes are not easily discerned, unless the membrane be held up to the light, when their opacity admits of their being observed; they circulate only the colorless parts of the blood, and are termed by some anatomists the exhalents: these vessels will, however, under inflammation, circulate red blood, when the redness of the surface of the membrane proves the abundance of its vessels. Numerous absorbents also enter into the composition of these membranes. Nerves have not yet been traced to them.

Among the physical properties of these tissues may be remarked their extensibility and contractility, which is proved by the size they acquire in dropsy, and the power they have of resuming their natural size upon the removal of the extending cause: but the whole of this extension is not to be attributed to the texture of the membrane only, but in part to the unfolding of its duplications from the pressure of the fluid.

The splanchnic membranes possess this extensibility to a greater degree than the synovial capsules.

The function of the serous membranes is to secrete and reciprocally absorb their natural fluids, always maintaining a certain quantity within their cavities for the purpose of lubricating their internal surfaces, and diminishing, therefore, the friction of the parts upon each other; if, however, from any cause, such as an increased arterial action producing too abundant a secretion, or the absorbents have their activity diminished, then the cavity so affected becomes distended with fluid, and dropsy of the membrane is produced.

The office of facilitating the motion of the organs which are covered by these membranes, is not the only use attributed to them; they are by some physiologists considered as essentially important in improving the assimilation which arises from the deposition and absorption of their secreted fluid. The fluid secreted by these membranes is not of the same appearance and quality in all of them: that produced from the splanchnic is supposed by most physiologists to be exhaled in a gaseous form, and becomes afterwards condensed by cold; but Magendie believes, that during life a small quantity is always to be found in a fluid state. It has much the same appearance as serum, offers nearly the same result from chemical analysis, is like it,—being in the greater part coagulable by heat, but leaves an incoagulable portion resembling in every respect the serosity of the blood.

The synovial capsules secrete a peculiar fluid, possessing very different qualities; the most remarkable of which is, its resemblance to the white of an egg, from which it has derived its name; and from its containing a small proportion of fibrin.

During the fœtal period of life, the serous membranes are found very thin, and generally less adherent to the surrounding parts, than in after periods. In more advanced epochs of life, they undergo changes as to numbers, as may be seen in the separation of the cavities of the tunicæ vaginales from the peritoneum.

The *sub-cutaneous serous membranes*—or superficial bursæ mucosæ, are found under the skin, in parts subjected to great motion and liable to pressure against bone. Such a membrane may, therefore, be invariably found between the skin and ligamentum patellæ; and which is frequently the subject of disease, from the continued pressure of kneeling. The texture of these sacs is the same as other serous membranes; but in their thickness they sometimes vary, between that of synovial and the splanchnic serous membranes, and, in a like manner, secrete a fluid within their closed cavities, for the purpose of facilitating the motion of the surrounding parts. Their developement and morbid changes are similar to the rest of the serous system.

The *synovial membranes*—which are classed with the serous, have been described when treating of the joints. (*Vide Vol. I. page* 179.)

The *internal serous* or *splanchnic membranes*—are those of which it is now my office more particularly to treat.

These membranes not only give more or less of a general covering to the viscera contained within the cavities of the body, but also are reflected from them, so as to give a covering to the parietes of the cavities themselves. They are found in different parts of the body, and are distinguished by particular names.

The peritoneum covers the organs of digestion, urinary organs, and those of generation; and serves an essential office in maintaining these parts in their relative situation, and diminishing the effects of friction, resulting from their motion upon each other.

The thoracic splanchnic membranes are three: two pleuræ, which surround the lungs and the parietes of the chest, and the pericardium, which is in the same manner reflected around the heart.

The arachnoid membrane is of this system, and forms the serous covering of the brain; while the tunicæ vaginales, in a like manner form coverings to the testes

Of all these the peritoneum is the largest, but as regards their composition, function, organization, and physical properties they resemble each other; they all line the internal surface of the cavities, and cover the viscera, which are contained within them; establishing at the same time a medium of connection, as well as a line of demarcation between the different organs, and serve in particular to facilitate their motion. The internal surface of these membranes is furnished with villosities, which become very apparent under inflammation, but when healthy it gives a shining appearance both to the viscera and the cavities themselves: an appearance evidently belonging to the serous membranes, for if it be stripped off, all the glistening disappears.

The peritoneum is the most complicated of all the serous membranes in its conformation; from having such various and numerous viscera to cover, and so large a cavity to line, that we shall find some difficulty in tracing it as a continuous membrane, throughout all its intricate foldings and attachments.

Although it has been said that the splanchnic serous membranes are connected with the viscera and parietes of the cavities, still it is to be observed that they are not adhering with the same firmness throughout every part of their extent. The degree of solidity of the adhesion is greatest while the membrane is attached to the organs, or to a continued surface of the parietes; but at the point where it is passing from the one to the other it is found much less firmly adherent, and thrown as it were into folds, so that the hollow viscera may become distended by the unravelling of these folds, and resume their form when the cause of distention is removed.

Such folds facilitate the enlargement of an inguinal hernia, the peritonial sac being formed of a duplicature; while on the contrary, an umbilical hernia, which is covered by a portion of peritoneum that lines and is firmly attached to the umbilicus, yields with greater difficulty, and is sometimes either torn through, or absorbed, in consequence of the pressure. This circumstance has given rise to the opinion of some surgeons, that umbilical herniæ are not furnished with a peritoneal covering.

In a state of health the splanchnic serous membranes secrete but a small portion of fluid which is capable of coagulation by heat, and is said by Dr. Bostock to contain—

Water	92	0
Albumen	5	5
Mucus	2	0
Muriate of soda . . .	0	5
In a	100	0

When these membranes are dried they lose their semitransparency and become yellow, their flexibility is diminished and they become elastic; moisture, however, restores their physical properties, but continued maceration dissolves them, shewing that they are composed of gelatine.

Pathology of the Serous Membranes.

The splanchnic serous membranes are very liable to inflammation, but not all of them equally so, as the pleuræ and peritoneum, and even the pericardium we find much more frequently affected than the tunica arachnoidea, or the tunicæ vaginales. When inflamed, however, they have a tendency to be alike affected with dropsy, formation of false membranes, adhesions, and accidental productions.

On examination of a dead body, adhesions of the pleuræ are very frequently found: and even where there had been no symptoms during life to lead to the suspicion of such alteration in structure: these adhesions are formed by a secretion from the membranes during a state of inflammation, and resemble the organizable matter which produces reunion of the edges of membranes when wounded.

A continued chronic inflammation of the serous membranes alters their structure; they become thicker, lose their transparency, and are liable to a morbid secretion within their cavities, sometimes of serum only, and at others of a milky fluid, and lastly of pus.

The false membranes that are found seem to be produced by becoming organized by the vessels of the inflamed membranes, and bearing the general characters of the cellular tissue, remain permanently as adventitious.

The splanchnic serous membranes are also liable to many accidental productions, as fibrous, cartilaginous, or osseous: these changes do not unfrequently occur on the pleura, but the peritoneum, and more particularly, it has been said, that portion of the peritoneum covering the spleen, is the subject of osseous deposit. These portions of bone are usually deposited in thin plates upon the membrane.

The serous membranes are very liable to be transformed into a cellular tissue; nor, as Andral has observed, need it create much surprize when we find in health these tissues frequently performing functions for each other. Thus, when a synovial bursa is found in one individual, in another there is only found cellular tissue, lubricated with a fluid more abundant and unctious than the usual secretion of that tissue. Meckel gives several reasons for believing in the natural affinity between the serous and mucous tissues, among which are the following:—First, that their exterior aspect is similar; and if the cellular tissue be inflated, small cells are produced, which are not to be distinguished from the finer serous textures. Such cells are seen in the omentum, and the tunica arachnoides, &c. Secondly, that like cellular structures, nerves have not been traced to them. Thirdly, that the functions of each are the same; namely, exhalation and absorption: and there are other arguments in favour of this hypothesis. One grand anatomical difference separates these two systems: namely, that the serous membranes form close sacs, while all mucous membranes open upon the surface. We shall presently see a decided distinction in the results of morbid action. The various cysts which are so frequently found in the body are similar to the serous membranes, presenting closed pouches, and an internal secreting surface, which pours out a lubricating fluid. Such cysts are found at the extremities of the stump of amputated limbs, in cases of unreduced dislocations, and non-united fractures. Mr. Brodie mentions having found a large serous cavity between the skin and the protuberance of a distorted spine. From these facts we may infer that the cellular membrane, under the necessity for altered function, may undergo a change in structure, rendering it capable of performing its new office, as we see pressure and motion will convert it into a synovial cyst; and in the same manner, the false or adventitious membranes, resulting from inflamed serous bags, will become transformed into a cellular tissue so as to enable them to perform the office of the common connecting medium. These newly-formed cysts are liable to various transformations, being convertible into the fibrous, cartilaginous, or osseous tissues; and their secretions are also found to be extremely variable, indeed, from the natural serous lubricating fluid, to all the varieties of pus, and even malignant formations. But the principal desideratum for the surgeon, connected with the pathology of the serous membranes, and more especially of the splanchnic, is, their tendency to the adhesive inflammation.

This peculiar result of inflammation, whether acute or chronic, forms the grand pathological feature connected with this class of membranes. The constant attempt of nature to repair injuries, and guard against the fatal effects which would occur in many such instances, is here most beautifully exemplified. When a wound of any serous cavity takes place, unless the accidental lesion be instantly fatal, or certainly irremediable (in which latter case, no restorative means are even attempted by nature), the first effort is to set up an adhesive inflammation. Some of the loose floating viscera come in contact with the external wound of the parietes, and a close adhesion between them takes place,—shutting up the opening into the general cavity; nay, more, if the wound pierce not only the parietes, but even a viscus,—as, for instance, a small intestine,—the wounded portion of the gut comes in contact with the exterior wound, and prevents the almost certainly fatal results of effusion of the intestinal contents into the serous cavity of the abdomen. Again, in severe diseases of articular surfaces, this form of inflammation sometimes steps in, and supersedes the last sad resource of the surgeon, amputation, by producing adhesion of the surfaces, and obliterating the joint. This form of inflammation, when perfect, consolidates the part, and produces anchylosis.

I have not yet spoken of the similarity between the living membrane of arteries and the serous tissues, because the analogy is not complete; but I may be permitted to state, that in external characters its smoothness and polish, its want of red blood-vessels and nerves in the healthy state, its elasticity and general aspect, lead me to infer a close relation between them; while the effects of injury to the inner coat of an artery is well known to the practical surgeon as productive of an inflammation, similar to that of serous textures. It forms our best safeguard in many of the higher operations of surgery; as ligatures on these structures well exemplify.

Simple inflammation produces other results in serous membranes, as merely thickening, for example in the white spots on the serous covering of the heart; and tubercular granulations, as in the affection of the peritoneum, described by Barron: also false membranes, dense bands, and various adventitious productions, frequently found in the larger serous cavities. Many of these accidental productions of the serous membranes are resolvable into distinct cellular tissue; as we have frequently had occasion to witness in old adhesions of the lungs to the ribs; and internal bands within the abdomen, which not unfrequently give rise to fatal strangulations of the intestines. Many bony concretions found within closed sacs, are probably dependant on morbid conditions of the serous textures; as the loose concretions in synovial capsules, and tunicæ vaginales. May we not also refer to a similar source, various serous cysts, which are generally but erroneously called hydatids; especially the kind known by the name of acephalous cysts.

These matters are, however, more the province of the morbid anatomist to enquire into, and would not here be introduced were it not for the surgical deductions which may be usefully inferred from such observations.

The structure, physiological and pathological considerations of the peritoneum being duly appreciated by the student, he will find it better next to study the relative position of the organs contained within the cavity of the abdomen, before he traces all the attachments of the peritoneum; to do which he would necessarily be obliged to displace the viscera, and thus preclude the possibility of learning their precise relative boundaries. But as a necessary preliminary to this investigation, it is advisable to gain a correct knowledge of the anatomical divisions of the external parietes of the abdomen.

LECTURE XXIII.

OF THE ABDOMEN AND ITS CONTENTS.

The abdomen is that part of the body situated between the chest and the lower openings of the pelvis; it presents a figure of an oval form, being more or less convex anteriorly; but its figure and dimensions vary at the different epochs of life, as well as from the degree of distention of the viscera proper to it.

The comparatively larger size of the abdomen in the infant, its apparent flatness and contraction at the adult period, as well as its greater vertical dimensions in the female, are subjects rather for the consideration of the physiologist than the anatomist, and I shall therefore refer my readers to physiological authors. It is right to observe, however, that the capacity of the abdomen is greater than that of either the skull or chest, and its size less determined, in consequence of its parietes being made up principally of soft parts; while that of the scull is completely formed by the bones of the cranium, and the capacity of the chest limited to the motions of the ribs and sternum: hence it is that effusion into the abdomen is not attended with the same danger, as when it occurs in the cranium or chest. The capacity of the abdominal cavity seems to be in proportion to the necessity for food, and the kind of food taken; thus it is found that the abdomen in the infant is comparatively large when a great quantity of nutrition is required; and becomes much less capacious in old age, when the activity of digestion is diminished, although its external parietes are at that period enlarged from the accumulated deposition of adeps.

The abdominal cavity is bounded, *above*, by the diaphragm and the ribs to which that muscle is attached; *below*, by the ossa innominata, and the muscles which fill up the pelvic openings; *behind*, by the lumbar vertebræ, and muscles of the loins; *laterally*, by the false ribs, ossa ilia and abdominal muscles and their tendons.

There are some anatomists and physiologists who condemn the term, cavity of the abdomen, because the parietes are always in contact with their contents; but as it is the term in common use, I cannot see any just reason for adopting any other name for the space which contains the abdominal viscera.

The abdomen is divided into an *external* and *internal* surface.

The external surface is covered by the skin, and is not only divided into an anterior, two lateral, and a posterior region; but, for physiological as well as surgical and medical purposes, to enable us in description more accurately to speak of the relative position of its contents, it has been found necessary to subdivide the abdomen into several arbitrary regions.

With this object in view, the abdomen has been divided first, into three regions, described by drawing two lines transversely across its surface,—the upper extending between the extremities of the cartilages of the ninth ribs, and the lower one between the anterior and superior spinous processes of the ilia.

The upper region, situated above the line drawn from one rib to the other, between it, the sternum, and the ribs, is termed the *epigastric* region. The middle compartment between the two lines is called the *umbilical* region. While the lower, which is bounded above by the line drawn from one ilium to the other, and below by the os pubes and the ligaments of Poupart, is termed the *hypogastric* region. But these divisions are each further subdivided into three regions by drawing a vertical line on either side from the junction of the cartilage of the ninth rib with the eighth, to the spinous processes of the pubes.

The epigastric region thus divided in its middle compartment, immediately under the ensiform cartilage, is termed the *scrobiculus cordis;* while its lateral regions, from being situated under the false ribs, are termed the right and left *hypochondriac* regions. The middle region in its centre retains the name of *umbilical;* but laterally, is called the right and left *lumbar* region. The inferior division or *hypogastrium,* in the centre gains the name of *pubic* region; while its lateral surfaces are called its *iliac* regions.

Such divisions over a continuous surface may appear, at first sight, not only arbitrary, but useless; but, upon bearing in mind the numerous viscera which are contained within the cavity of the abdomen, performing such different functions; and then learning the different positions of these viscera in relation to the nine regions which have been described,—it at once appears obvious, that a just diagnosis in the diseases of the abdominal viscera must be infinitely facilitated, and the surgeon gain great practical knowledge in the treatment of penetrating wounds, and in the various operations connected with abdominal surgery.

It may not be unadvisable for the student in this period of his study of the abdomen, to re-consider what he had learnt during his dissection of the abdominal muscles:—such as the direction of the fibres of these muscles, which so cross each other, as not only to adapt them, in the best possible manner, to sustain the viscera contained within the abdomen; but also, at the same time, to prevent their protrusion; and further, that the arrangement of their muscular and tendinous fibres render them capable, during their contraction, of acting with equal force through every part of the abdomen. The situation of the umbilicus and of the rings, each diminishing the power of resistance of the abdominal parietes at the parts where they are placed, are also subjects worthy at this time of the consideration of the pupil.

The next step is to remove the abdominal muscles; and it would be well if this dissection were performed in a manner which is not usually recommended, but which, although difficult in execution, would, when performed, thoroughly repay the student for his labour, by giving to him a just view of the fasciæ which actually form the true parietes to the abdominal cavity. Dissecting away the transversalis muscle of the abdomen completely from its attachments, will expose the fascia transversalis lying upon the peritoneum. This membrane may now be traced to its connection with the anterior layer of the fascia lumborum above, and laterally with the fascia iliaca below, so as completely to inclose the viscera and peritoneum in a fascial bag, excepting at the roof of the abdomen, where it is bounded by the concavity of the diaphragm, in the form of a cupola. A portion of the fascia transversalis should now be most carefully raised from the peritoneum around the umbilicus, for the extent of three inches above and below the navel, and two inches on either side; by which there will be exposed four cords,—one running upwards from the umbilicus, and three taking their course towards it from the hypogastric region. These cords, from lying upon the external surface of the peritoneum, have been improperly termed the ligaments of the peritoneum; but they are, in fact, the remains of the umbilical cord. The upper one, the now obliterated umbilical vein, which had, during the fœtal period of life, conveyed the blood from the mother to the embryo; while the two lateral cords below are the impervious remains of the umbilical or hypogastric arteries, which had in utero conveyed the blood back again from the fœtus to the placenta of the mother. The middle cord below is termed the urachus, which passes from the fundus of the bladder to the umbilicus; it is described by anatomists, at every period of life to be an impervious cord, and the use assigned to it in the human subject is, to prevent the displacement of the bladder. In the lower animals it is found to be a hollow tube, conveying the urine which may be formed in the fœtal bladder to the alantoid membrane. It is yet a matter of doubt in my mind, whether or not it be pervious in the human fœtus; and from a case which I have lately seen, where there were malformations of the urinary and generative organs in a female child, and a discharge of urine from the umbilicus, I am inclined to believe the urachus remained as a hollow tube communicating with the bladder.

The peritoneum should now be laid open to expose its internal, as well as its external surface; which may be done by making an incision through it from the ensiform cartilage to the umbilicus, and from thence, on either side, to the spine of the ilium; and then turning down the inferior flap of the peritoneum which has thus been made, the umbilical arteries are seen projecting on the inner surface of the peritoneum, and forming it into two distinct pouches, on either side, an external and internal hypogastric pouch, or *cul de sac.* The external is the larger and deeper of the two, and is placed in the right iliac fossa, on the outer side of the umbilical artery, in a direction towards the internal ring and crural arch; so that it may in some instances lead to the occurrence of inguinal and femoral herniæ. The smaller and inner *cul de sac,* is placed between the bladder and obliterated umbilical artery, and leads therefore immediately downwards, behind the united tendons of the internal oblique and transversalis muscles, towards the external ring: it is therefore liable to be protruded in direct or ventro-inguinal herniæ.

The structure and the physiological considerations of the peritoneum being duly appreciated by the student, he will find it better next to examine the relative position of the organs contained within the cavity of the abdomen, before he traces the various attachments of the peritoneum; to prosecute which, he would necessarily be obliged to displace the viscera, and thus preclude the possibility of learning their precise relative situations and boundaries.

The viscera contained within the cavity of the abdomen, are divided into three classes: the organs of digestion, with their assistants the chilopoietic viscera; the organs for the secretion and excretion of urine; and parts of the organs of generation.

But both collectively and individually these viscera, it is to be remembered, are placed without and behind the closed sac formed by the peritoneum; which, in fact, is to be considered as a cavity within a cavity, lining the parietes of the abdomen, and giving more or less of a partial or general covering to the separate organs.

On laying open the cavity of the abdomen, by making an incision through the parietes from the ensiform cartilage to the pubes, and a second transverse incision from the extremity of the last rib on the one side to the other, the following organs present themselves to view:—

The acute edge of the liver, particularly of the right lobe, with the fundus of the gall bladder. In some subjects much more of this organ is exposed in this view than in others, depending upon age, sex, and previous state of health.

The stomach; with a small portion of the duodenum, the greater and less omentum, and such a portion of the small intestines as are not covered by the great omentum. The quantity of small intestines exposed, varies in proportion to the extent of the great omentum, which, in some subjects, reaches much lower than in others.

Such are the parts which are brought into view without any displacement of the viscera. Having named the contents of the abdomen, and those organs which present themselves to view on laying open the cavity, I shall proceed to describe the boundaries of each organ in particular, and their relative position with respect to each other, commencing with the organs of digestion.

The *stomach*—the principal organ of digestion, is a musculo-membranous bag, of an irregular conoid form, lengthened from left to right and from above to below, being placed between the œsophagus and the duodenum; it is situated in the epigastrium, principally occupying the left hypochondriac region; crosses the scrobiculus cordis, and terminates, at the junction of this region with the right hypochondriac, in the duodenum. It is bounded above by the liver and diaphragm, below, by the transverse arch of the colon and the great omentum; before, by the ensiform cartilage and cartilages of the last false ribs, behind, by the pancreas; on the left, by the spleen, and on the right, by the duodenum. The direction of the stomach is oblique from above to below, and from left to right; and its superior portion, which we shall find forms its lesser curvature, extends from the left of the tenth to the right of the twelfth dorsal vertebra.

At the termination of the stomach to the right of the twelfth dorsal vertebra, the intestinal canal commences; and, taking a very tortuous course through the various regions of the abdomen, terminates at the anus. The length of this canal at the adult period of life, is from six to seven times the length of the body; in the fœtus it is even longer; and comparative anatomy teaches us, that the intestinal canal is longest in vegetable feeders, shortest in carniverous, and intermediate in the omniverous class.

The *intestinal canal* is divided into small and large intestines: the small commence at the pyloric or right extremity of the stomach, and terminate in the large intestines, at the right iliac fossa; the large intestines commence at the termination of the small in the right iliac fossa, take a circuitous course within the cavity of the abdomen, and terminate at the anus.

The *small intestines* are subdivided into duodenum, jejunum, and ileum; which, being bounded in front by the great omentum and transverse arch of the colon, these parts must be turned upwards on the chest to examine their relative position; remembering, however, that the first two inches of the duodenum will be still concealed by the omentum.

The *duodenum*—the commencement of the intestinal canal, is so called from being in length equal to the breadth of twelve fingers; it extends from the termination of the stomach, on the right of the twelfth dorsal vertebra, to the second lumbar where it terminates on the jejunum. Passing from its commencement to its termination, it takes a tortuous course. For the purpose of facilitating its description, it is divided into three portions; a superior transverse, a middle vertical, and an inferior transverse portion. The superior transverse portion of the duodenum, takes its course from the stomach upwards, backwards, and to the right, as far as the neck of the gall bladder; being in its whole length in the right hypochondriac region. From thence the vertical portion descends into the right lumbar region, resting on the anterior surface of the right kidney and vena cava inferior. The inferior transverse portion passes inwards, and slightly upwards to the left, crosses the second lumbar vertebra, the aorta, and right venal vessels, to terminate in the jejunum. The duodenum in taking this course, describes a semicircle; the convexity of which is directed outwards and to the right; while the concavity, which embraces the head of the pancreas, is directed inwards and to the left. The duodenum is not in all its length equally covered by peritoneum, as its middle or vertical portion is only anteriorly covered by the upper lamina of the transverse mesocolon. Its upper portion is often found tinged with bile, but which probably is occasioned by the transudation of that fluid after death.

The duodenum is bounded *above*, by the liver and gall bladder; *below*, by the inferior lamina of the mesocolon: *anteriorly*, by the anterior layer of the mesocolon, the ascending and transverse arch of the colon; *posteriorly*, by the right kidney, the vertebral column, aorta, vena cava, and right pillar of the diaphragm: on its inner side, by the pancreas; and on its outer, by the muscular parietes of the right lumbar and hypochondriac regions.

The remaining portion of the small intestines, is subdivided into jejunum and ileum; they extend from the left of the second lumbar vertebra to the right iliac fossa, forming numerous convolutions in their course, which pass from above to below and from left to right, occupying the umbilical and hypogastric regions. They present convexities anteriorly, concavities posteriorly, and are held in their situation by that portion of peritoneum which is termed the mesentery. Although this portion of the intestinal canal is by anatomists subdivided into jejunum and ileum, still the division is perfectly arbitrary, there being no distinction between them in their structure; but the upper two-fifths, which occupy the umbilical region, is called jejunum; and the lower three-fifths, situated within the iliac regions, is named the ileum. These two portions of the small intestines are bounded *above*, by the transverse arch of the colon; *below*, by the bladder and rectum: *before*, by the omentum; *behind*, by the mesentery, cæcum, and the ascending and descending colon.

The termination of the ileum in the cæcum,—with which it forms a right angle,—should be here attentively noticed; after which, the course of the large intestines may be traced.

The large intestines form about one-fifth of the whole length of the intestinal canal; they commence in the right iliac fossa, and terminate at the anus; they take a circuitous course, and are subdivided into *cæcum* or *caput colli*, *colon*, and *rectum*.

The *cæcum*, or caput colli, is that portion of the large intestines situated in the right iliac fossa, below the termination of the ileum. It is somewhat conical in its form,—the base being situated above, and its apex below. From its under and inner surface a lengthened process, termed the processus vermiformis, extends over the brim of the pelvis and iliac vessels into the cavity of the pelvis. The processus vermiformis is between two and three inches in length, about the size of a quill, and opens from the cæcum, below the termination of the ileum. The use of this organ is unknown; but in the fœtus its dimensions are relatively larger than in the adult. The structure of this process varies remarkably in different animals; in many, it is wholly wanting; in others, it is of a large size, or more than one in number. The cæcum is held in its situation by a portion of peritoneum, which usually only covers its anterior surface, but does sometimes so surround this intestine as to form a perfect meso-cæcum. The cæcum is bounded *above*, by the ascending colon and right kidney; *below*, by Poupart's ligaments; in front, by the abdominal muscles, and sometimes by convolutions of the ileum; behind, by the psoas magnus and iliacus muscles; and on the inner side, by the termination of the ileum, which passes into it in a manner which will be described when treating of the structure and organization of the intestinal canal.

The *colon* commences in the right iliac fossa, above the entrance of the ileum, and terminates at the left sacro-iliac symphisis in the rectum; to reach this point it passes first, upwards, then across the abdomen to gain the left hypochondriac region; then descends into the left iliac fossa, where it forms a peculiar turn which terminates in the rectum. This disposition of the colon, has led to its division into four distinct portions; the *ascending, transverse arch, descending* and *sigmoid flexion:* each of which requires a separate description.

The *ascending colon* extends from the right iliac fossa, through the right lumbar to the right hypochondriac region; it is bounded *above*, by the right lobe of the liver, which it marks with a depression; *below*, by the cæcum, and termination of the ileum: *anteriorly*, it is covered by the small intestines; *posteriorly*, it rests upon the quadratus lumborum muscle, the right kidney and duodenum; *internally*, it is connected with the inferior lamina of the transverse meso-colon, and right layer of the mesentery; and *externally*, it is bounded by the abdominal parietes. Its size does not much exceed that of the small intestines; but there are, even at first view, sufficiently distinguishing marks, which will be hereafter described. It is not very firmly tied down in its course, being connected with the quadratus lumborum muscle and kidney by a considerable quantity of loose cellular membrane.

The *transverse portion*, or *arch of the colon*, extends from the right hypochondriac region, across the lower part of the scrobiculus cordis, into the left hypochondriac region; in its course forming a convexity looking downwards, and a concavity upwards. Such are the regions which anatomists usually describe the transverse arch of the colon to occupy; but the extreme convexity of the arch, I think, is generally found extending into the umbilical region. This portion of the colon is bounded *above*, by the stomach; *below* and *behind*, by the small intestines; and in *front*, by three layers of the great omentum: the right commencement of the arch is bounded above, by the right lobe of the liver; while its termination in the left hypochondriac region is in contact with the spleen: its concavity is directed upwards and backwards towards the spine, with which it is connected by peritoneum; and its convexity is turned downwards and forwards, toward the anterior abdominal parietes.

The *descending*, or *left portion of the colon*, extends from the left hypochondriac into the upper part of the left iliac region. It is bounded *above*, by the spleen; *below*, by the sigmoid flexion of the colon: *anteriorly*, by the large left extremity of the stomach when that organ is empty, and by the small intestines; *behind*, it lies upon the kidney, the quadratus lumborum, and iliacus muscles, to which it is connected by loose cellular membrane: the peritoneal covering to this part of the intestine, as in the right side, is connected only with its anterior and lateral surfaces.

The remaining portion of the colon, which, from the course it takes to the junction of the last lumbar vertebra with the sacrum, is called the *sigmoid flexion*, or *left iliac colon*—and describes a double curve in the form of the letter S. It is bounded *above*, by the descending colon; *below*, by Poupart's ligament: *before*, by the small intestines, spermatic vessels, and left ureter; and *behind*, it rests upon the psoas magnus, and iliacus muscles. The sigmoid flexion is very loosely connected with the iliac fossa, frequently descending into the pelvis. When a portion of this intestine, or, on the right side of the cæcum, become protruded from the abdominal cavity, they are not usually closed in a peritoneal sac.

The last portion of the intestinal canal is the *rectum*—which begins where the sigmoid flexion of the colon ends, opposite the left sacro-iliac articulation, and extends to the anus. The commencement of this intestine is directed slightly from left to right, and from above to below, taking the curved form of the sacrum, until it reaches the junction of the sacrum with the os coccygis, when it takes a direct course towards the perineum. The rectum is firmly fixed in its situation by the peritoneum, which does not however give it an equal covering throughout its whole extent; its upper third is surrounded by this membrane forming in this situation the meso-rectum; the middle third has only an anterior covering from the peritoneum, which is reflected from the bladder in the male subject, and from the vagina in the female; while the lower or anterior third has no peritoneum attached to it. Unless distended the rectum appears smaller than the colon, but is capable of great distention, especially in its lower third, where it is not covered by peritoneum. It is bounded *above,* by the sigmoid flexion of the colon; and *below,* by the anus: *anteriorly,* by the bladder in the male, from which it is separated by small intestines, which fall into the *cul de sac* formed by the peritoneum as it is reflected from the posterior surface of the bladder to the fore part of the rectum; it has also anterior to it the vesiculæ seminales, and the prostate gland; in the female it has before it the uterus and the vagina, from which however it is separated, as from the bladder in the male, by the small intestines: *posteriorly,* it lies *above,* upon the sacrum and os coccygis, connected to the former by the meso-rectum,—between the folds of which are placed the hæmorrhoidal vessels and nerves; and *below,* it rests upon the levator ani muscle: *laterally,* the rectum is covered by cellular membrane, and the levator ani muscles.

The extent and relative position of the alimentary canal being perfectly understood by the pupil; the next step should be, before these organs are removed for the purpose of studying their form, structure, and organization,—to learn the extent and reflections of the splanchnic serous membrane which gives these, and the parietes of the abdomen, a more or less general covering. This could not have been traced before, without so displacing the intestinal canal as to render it impossible to demonstrate the natural position of the different viscera.

The *peritoneum* has derived its name from the Greek word περιτεινω, to surround; but which, however, it does not do, only giving a partial investment, always leaving some portion of every organ uncovered, for the entrance of its vessels and nerves; these, therefore, do not penetrate this membrane to pass to the different viscera, but are enclosed between its folds as it is reflected from one organ to another. Like all the serous membranes, the peritoneum forms a closed bag, without any external opening; and if it could be dissected from the different viscera and parietes of the abdomen without being cut into, it would be a large empty bag, but which presents an irregular surface within the abdomen from the numerous folds, processes, and prolongations it makes, partially enclosing the various and irregularly formed organs. Some idea, perhaps, may be gained of the course and attachments of this membrane, by supposing an opening to be made into the abdomen, and a quantity of colored varnish to be poured in, and the body to be shaken; the varnish being allowed to dry, upon inspection it would be found to have given a polished surface to the parietes of the abdomen, and to every surface of the viscera to which it would become applied: thus shewing the extent of the peritoneal surface.

The peritoneum presents an exterior rough surface, which is attached to the parietes of the abdomen, and to the viscera, by cellular membrane; and a smooth internal secreting surface, which is continuous throughout its whole extent, and may be traced without interruption,—the visceral smooth portion being opposed to the parietal, while its secretion lubricates the surfaces so as to prevent friction.

The best mode of tracing the peritoneum throughout all its attachments is, by reflecting the anterior parietes of the abdomen, which have already been described as being cut through by two incisions, commencing from the umbilicus and extended to the anterior and superior spinous processes of the ilia. On the posterior surface of this triangular flap, the peritoneum will be seen passing downwards towards the pubes, and extending laterally along the inner surface of the fascia transversalis, into the iliac regions; tracing it downwards, and remarking at the same time the three cords which are placed between it and the parietes of the abdomen, we shall observe how it becomes reflected posteriorly to these cords on to the fundus of the bladder, leaving the anterior surface of the bladder, and a space between it and the pubes, uncovered;—a point of surgical importance, as in this situation, in retention of urine the bladder may be punctured above the pubes, without injury to this splanchnic serous membrane. It is from thence continued backwards, along the posterior region, and the posterior half of the lateral regions of the bladder, as far as the bases of the vesiculæ seminales; and then quits this organ to be reflected upon the rectum, leaving a pouch between the two, into which the small intestines usually fall. While the peritoneum is covering this portion of the bladder, it is bounded above by the urachus, laterally by the remains of the umbilical arteries, and below and in front by the vesiculæ seminales and terminations of the ureters. The portions, also, which extend laterally from the sides of the bladder into the iliac fossæ, are worthy of particular examination, from the two pouches which they form; the inner one between the bladder and umbilical artery, leading directly towards the external ring, while the outer one, between the umbilical arteries and iliac fossa, is directed towards the internal ring by the spermatic cord. It is these portions of peritoneum which form the hernial sacs in direct and oblique inguinal herniæ.

The peritoneum then comes in contact with the anterior surface of the middle third of the rectum, extending up as high as the junction of the third and fourth pieces of the sacrum, where it winds around the sides of the intestine to form the meso-rectum, and retains this name as high as the sacro-lumbar articulation; where, as it leaves the sacrum, it runs up to the fourth lumbar vertebra, stretching out on either side to tie down the cæcum and colon in the iliac fossæ. From the upper part of the fourth lumbar vertebra, this membrane leaves the spine and passes forwards to surround the small intestines forming the posterior layer of the mesentery; and then winding around their convex edges and anterior surfaces, passes back again to the second lumbar vertebra;—thus forming the anterior layer of the mesentery, and extending laterally into the lumbar regions to tie down the ascending colon on the right side, and the descending colon and kidney on the left side. It may be observed, therefore, that the mesentery extends from the fourth to the second lumbar vertebra; being, below, continuous with the right and left lumbar and iliac meso-colon, enclosing all the convolutions of the small intestines. The anterior layer of the mesentery then passes downwards and forwards from the second lumbar vertebra, to the under surface of the transverse arch of the colon; forming the united root of the mesentery and meso-colon, behind which, and between it and the second lumbar vertebra, the duodenum crosses, to terminate in the jejunum. When this layer has arrived at the convex edge of the transverse arch of the colon, to which it is firmly attached; it leaves that intestine, and passes downwards in front of the small intestines, and consequently in front of the anterior layer of the mesentery; and in this situation forms the posterior layer of the great omentum, extending, as has been before observed, to a greater or less distance, in different individuals, downwards towards the pelvis. It then turns forwards upon itself, and passes upwards; thus producing a kind of bag, the surfaces of which, however, are not in contact: this reflected portion forms the anterior layer of the great omentum, and passes upwards in front of the transverse arch of the colon, but *not* in contact with it, as high as the stomach,—the convex edge and anterior surface of which it now covers and adheres to; extending laterally on the left side to cover the spleen, and on the right side the anterior surface of the duodenum, and the vessels passing between it and the liver: from the smaller curvature of the stomach, it passes behind the left lobe of the liver to the diaphragm,—in this extent forming the anterior layer of Glisson's capsule, and of the less omentum; and having reached the diaphragm, it becomes reflected from it upon the concave under surface of the left lobe of the liver; and in the short space between the diaphragm and obtuse edge of the left lobe, it forms the inferior layer of the left lateral ligament of the liver. It continues to pass from behind to before, along the under surface of the left lobe to its acute edge, over which it turns and spreads, both right and left, to give a covering to the superior convex surface of the right as well as the left lobe of the liver; but at this point, in passing from the left to the right side, the peritoneum envelopes the remains of the umbilical vein, and forms the round ligament of the liver; while in passing backwards, covering the superior surface of both lobes of the liver, and connecting it with the diaphragm, it forms the suspensory ligament, which separates into two layers on the obtuse edge of the liver,—one layer passing to the diaphragm on the left side, to complete the left lateral ligament of the liver, and the other on the right side, to form the superior layer of the right lateral ligament. The triangular separation of the two layers of the suspensory ligament, is termed the coronary ligament. The peritoneum then proceeds as a wide extended continuous membrane upwards, from the obtuse edge of the liver, upon the concave surface of the diaphragm; from thence upon the anterior parietes of the abdomen, down to the umbilicus, from whence we began our description.

The student should now well consider this description, and trace the peritoneum in the foregoing order, by raising the organs separately, and examining carefully the attachment of the peritoneum to the spine; during which examination, he will naturally discover that he has not yet learned how the ducts from the liver, the hepatic artery, and vena porta, are enclosed in peritoneum; how the covering to the posterior surface of the upper transverse portion of the duodenum, to the concave surface of the right lobe of the liver, to the anterior surface of the pancreas, to the posterior surface of the stomach, and to the anterior surface of the transverse arch of the colon are formed; together with the posterior layer of the lesser, and the two inner layers of the great omentum.

To understand this, he must again examine the anterior layer of the great omentum, where it covers the superior or anterior surfaces of the stomach; from the small curvature of which a layer has been described as passing upwards, behind the left lobe of the liver; but from the right side of the stomach, a portion of this same layer proceeds upon the anterior surface of the duodenum, the hepatic artery, vena porta, and ductus communis choledochus, underneath which there is an opening, termed the foramen of Winslow: through which opening this portion of the peritoneum passes, and in consequence of being pushed through a hole, forms a kind of pouch, presenting therefore two layers; this pouch is prolonged upwards to cover the under surface of the right lobe of the liver, reaches the diaphragm, and there forms the inferior layer of the right lateral ligament to the liver; it then passes downwards upon the spine, covering with its posterior portion the pancreas, and with its anterior the inferior surface of the stomach, and of the first third of the duodenum. The pouch, consequently the two layers, then pass forwards and downwards from the stomach to the anterior surface of the transverse arch of the colon, with which the posterior layer is in contact; below this intestine they still continue downwards, between the posterior and anterior layers of the great omentum, and complete the four layers of that process of the peritoneum;—three of which layers are anterior, and one posterior, to the transverse arch of the colon. That portion of the peritoneum which surrounds the hepatic vessels and duct, is termed Glisson's capsule; and contains the hepatic arteries to the left, the hepatic ducts on the right, and the vena porta on a plane behind and between the two.

It should further be observed how the peritoneum, in being reflected towards the spine from the different organs which it covers, leaves a space between its layers for the passage of the vessels and nerves to the viscera; and how completely every viscus is situated externally to this closed sac. Between the layers of the mesentery the lacteals should be observed, directing their course upwards, and rather obliquely to the right, towards the right crus of the diaphragm to terminate in the thoracic duct.

Having finished the reflections of the peritoneum, and having already described the relative position of the stomach and intestinal canal, we may now proceed to remark the situation of the liver, pancreas, and spleen, and their connections with the organs of digestion.

The *relative position of the liver:*—this is the largest gland in the body, and occupies a considerable portion of the epigastric region of the abdomen: its right side or large lobe is placed in the right hypochondriac region, above the duodenum and ascending colon; the notch or division between it and the left lobe, is placed in the scrobiculus cordis; and its smaller left side or lobe, occupies a part of the left hypochondriac region. The liver is bounded *above,* by the diaphragm; *below,* by the stomach, and pancreas; in the *centre,* by the duodenum and ascending colon on the right side, spleen and descending colon on the left: *behind,* by the spine, crura of the diaphragm, aorta, thoracic duct, vena azygos and vena cava; in *front,* by the ensiform cartilage, and parietes of the abdomen; and *laterally,* by the cartilages of the false ribs. The duct of the liver passes from about the centre of its under surface to enter at the angle formed by the junction of the middle vertical with the lower transverse portion of the duodenum; and in the space between the liver and the entrance of the duct into the duodenum, the finger may be passed through an opening termed the foramen of Winslow, which passes under the hepatic duct, vena portæ and hepatic artery; and allows of that reflection of the peritoneum which, surrounding these vessels, passes to cover the pancreas and posterior surface of the stomach. It is this duplicature which constitutes the capsule of Glisson, containing, besides the hepatic artery to the left, the hepatic duct to the right, and the vena portæ in the middle, but on a plane posterior to the two; absorbent vessels, and the hepatic plexus of nerves, which surround them.

The *relative position of the pancreas.*—To expose this organ, the liver should be raised, the stomach drawn downwards, and the layers of the less omentum torn through. It is a long narrow viscus, placed obliquely across the abdomen, in front of the junction of the last dorsal with the first lumbar vertebra, crossing the lower and posterior part of the epigastric region. It is bounded in *front,* by the stomach and less omentum; *behind,* by the crura of the diaphragm, vena cava, aorta, and superior mesenteric artery: on the *right,* by the duodenum; on the *left,* by the spleen: *above,* by the cœliac and splenic vessels; and *below,* by the superior mesenteric artery, which separates it from the third portion of the duodenum. The duct of the pancreas opens into the duodenum in common with the ductus communis cholodechus, but cannot be traced until the organization of the pancreas is examined.

The *relative position of the spleen.*—It is deeply seated in the left hypochondriac region; bounded in *front,* by the left extremity of the stomach; *behind,* by the larger muscle of the diaphragm, corresponding to the ninth, tenth, and eleventh left ribs; to the *right,* by the pancreas; *below,* by the descending colon and capsular renalis; and *above,* by the left lobe of the liver and concavity of the diaphragm. It is connected to the diaphragm and stomach by the reflections of the peritoneum, in consequence of which it is subjected to the motions of these parts.

Having observed the relative position of the organs of digestion, with their assistants the chylopoetic viscera, within the cavity of the abdomen; they may now be removed from the body, in order to examine their structure and organization. As this investigation should be rendered consistent with a physiological view of their functions, I shall give them in the following order: first, the œsophagus, stomach, and duodenum; then proceed to the liver, pancreas, and spleen, previously to the remaining portion of the intestinal canal,—it being subservient to the function of the above-named organs.

It will be observed, I have here named the œsophagus, the principal part of which is contained within the cavity of the thorax; but as a portion of it is also contained within the abdomen, and as it forms a part of the digestive apparatus, its intimate structure and organization cannot be given at a better time than the present: leaving the minuter description of its relative position within the chest, until we speak of the contents of that cavity.

Structure of the œsophagus.—The œsophagus is a muscular canal, lined by a mucous membrane. It commences from the lower part of the pharynx, opposite to the fifth cervical vertebra; passes through the posterior part of the cavity of the chest, enters the abdomen through the crura of the diaphragm, and to the left of the tenth dorsal vertebra, terminates in the stomach at its cardiac extremity.

This organ is composed of two coats: an outer, which is muscular; and an inner, which is membranous. The *muscular* coat is formed of two planes of fibres passing in opposite directions; the fibres of the external layer pass in a longitudinal direction, arising in part from the cricoid cartilage of the larynx, in greater abundance anteriorly and posteriorly, than at the sides, where they are less abundant, and the inner plane of circular fibres may be observed.

The longitudinal fibres are continued along the whole length of the canal; and diverging upon the stomach, are lost on that organ.

The circular fibres, or inner muscular plane of the œsophagus, pass in a transverse direction, having frequent interruptions in the portions of the circles they describe; as they reach the stomach, they become paler, and here terminate.

The *mucous* coat is a soft, spongy, whitish membrane, continuous above with that of the pharynx; but there appears to be a line of demarcation between it and the mucous membrane of the stomach below; it is furnished with a distinct cuticular covering, continued from that lining the mouth: in the human subject, it terminates at the cardia, in a sort of fimbriated border; but in some animals, it proceeds to line one half of the stomach. This interior coat of the œsophagus presents numerous longitudinal folds, which are produced by the contractions of its muscular parietes, and which must tend to facilitate the dilatation of the organ upon the passage of food. The muscular and mucous coats of the œsophagus, are connected with each other by a dense layer of cellular membrane, but which never contains adeps; it is found continuing itself into the folds of the mucous membrane, and constitutes the "tunica nervea" of the older writers. Mucous follicles are interspersed along the œsophagus in this cellular tissue; they resemble those of the pharynx, but are less numerous: they present minute open mouths in the furrows between the longitudinal rugæ, and are surrounded by the villi of the mucous membrane. The œsophagus, when empty, does not retain its cylindrical form, but is flattened from before to behind, when it produces transverse as well as the longitudinal rugæ. It is said by some anatomists to represent a double cone, the apices of which are connected in the centre, and the bases form the two extremities. This canal is supplied with blood by the inferior thyroideal artery in the neck, by the bronchial arteries and the aorta in the thorax, and by the phrenic and coronary arteries in the abdomen; the blood is returned by the corresponding veins. Its absorbents pass to the surrounding ganglia; and its nerves form a plexus, which is continued along the whole course of this organ to the stomach: they are derived from the pharyngeal and pulmonary plexus, the cardiac, the ganglia of the sympathetic, and the pheumo-gastric nerves, with their recurrent branches.

Practical Remarks.

The œsophagus, equally with other parts of the body, is very liable to inflammation, not only from a general tendency to disease, owing to its high degree of organization, but also from the peculiar function which it is destined to perform: thus it is exposed to numerous exciting causes from the various substances which are swallowed. When inflamed, the mucous coat assumes a redder color than natural, has a pulpy appearance, and an increased degree of sensibility. A specific inflammation is supposed to be produced in the membranes lining the œsophagus and pharynx, from the bites of rabid animals, and which extends from the œsophagus to the coats of the stomach.

Stricture of the œsophagus, may arise from spasmodic affections of the muscular coat; from adventitious formations in the cellular membrane connecting the muscular and mucous coats; or, from diseases of the mucous membrane itself. Obstructions, from the two latter causes, require the use of the œsophageal bougie, as well as medical treatment, —which, in all cases, must be regulated by the peculiarities of constitutional circumstances.

Difficulty of swallowing, may also arise from a paralytic state of the muscular fibres of the œsophagus, which is principally denoted by the absence of pain, of any hardness, and of swelling in the course of the gullet,—through which a probang also passes without any impediment. The principal object in this disease is, to supply the patient with a sufficient quantity of food by means of a hollow bougie; the medical treatment being the same as in other paralytic affections.

Tumours in the neighbouring organs and tissues, may press upon the œsophagus, and produce dysphagia; this sometimes occurs from enlargements of the thyroid gland, aneurism of the arch of the aorta, and even from the formations of matter between the œsophagus and trachæa. The indications in each of these cases, will be obvious from the individual symptoms.

Foreign bodies frequently lodge in the œsophagus, either during deglutition,—from the peculiar texture, form, or hardness of the bodies swallowed; or from accidental causes. The effects produced, depend upon the part of the œsophagus in which they are lodged; when just at the commencement of the œsophagus, they endanger suffocation from pressure on the glottis: in these cases, an attempt should always be made to abstract them; for which purpose the finger may usually be employed, but sometimes it is requisite to use curved forceps. When bodies are lodged lower down in the œsophagus, if substances capable of being digested, they may be pushed into the stomach by a probang; but if the substance be of a nature to produce injurious effects in the stomach, attempts should be made to extract them; and even it may be necessary to resort to the operation of œsophagotomy.—It is here proper to mention, that great care is required in passing instruments into the œsophagus, not to mistake the opening into the glottis for the passage into the œsophagus: this accident is very liable to occur when the tongue is drawn forwards,—a mode recommended by some high authorities, but which I feel disposed to condemn; for when the tongue is drawn forwards, it raises the epiglottis, and leaves the passage into the larynx exposed to an ill-directed probang.

Organization of the stomach.—To examine this organ, and its relation to the chilopoietic viscera, it may be removed from the abdomen with a portion of the œsophagus, together with the duodenum, liver, pancreas, and spleen. The stomach is the organ of chymification, and consists of a large bag or pouch in which the food is received for that particular purpose. The form of the human stomach is best seen when distended with air; its general figure is that of a curved cone, the base of which is placed to the left, and the apex in a diagonal direction, downwards to the right. It presents a cardiac or splenic *left extremity,* communicating with the œsophagus; a pyloric *right extremity,* opening into the duodenum; two *curvatures,* the upper and posterior of which is the lesser, and is concave; the lower and anterior is the greater, and is convex: two *surfaces,* an anterior or superior, and a posterior or inferior. The stomach is composed of three coats, a peritoneal, a muscular, and a mucous or villous.

The *peritoneal* is the exterior covering, and is derived, as has been before observed, from the anterior layer of the great omentum, which covers its anterior and superior surface; while the duplicature which passes behind the hepatic vessels to form Glisson's capsule, covers the posterior or inferior surface of the organ. This coat adheres firmly by a short, dense, cellular tissue to the muscular coat, excepting at its curvatures, where spaces are left for the entrance of vessels and nerves; these spaces also contribute to the more ready distention of the organ.

The *muscular coat* is composed of fibres, much whiter and thinner than those of the œsophagus, and pass in three different directions. The superficial fibres pass in a longitudinal direction, and are continued from the external coat of the œsophagus, principally along the two curvatures of the stomach, being more apparent and stronger on the lesser curvature, especially towards the pyloris; the few which expand upon the two surfaces, are whiter and more irregular in their course. The second set of muscular fibres pass in a circular direction over the whole stomach; they commence at the left extremity, where they take a parallel course in an annular direction; never however completely encircling the viscus, but are lost or intermingle with each other: they are strongest at each extremity, and in the centre; in which latter situation they sometimes cause an hour-glass contraction of the viscus, which has led some physiologists to the belief that the left half was destined to receive the solid parts of food, and the right the more fluid. The third set consists of two broad bands of oblique fibres,—one extending from the left side of the cardia over the surfaces, and the other from the right side of the cardia over the great extremity; this layer seems as if it were continuous with the circular fibres of the œsophagus. A layer of dense cellular tissue unites the muscular fibres to the mucous membrane, and has been considered by some anatomists as a distinct coat.

The *mucous membrane*—or third coat of the stomach. To expose this coat, the stomach should be opened along its greater curvature, so as to preserve the cardiac and pyloric orifices.

The mucous membrane will generally be seen to be of a pale red color; frequently, however, it varies in its appearance, presenting patches of a dark brown or grey color, which are not to be mistaken for disease,—as they are found to exist without any previous symptoms of ill health which were likely to have produced them. The mucous coat of the stomach is disposed in numerous rugæ, differing in their size and appearance from those of the œsophagus; they take an irregular direction, oblique and transverse, apparently in some measure conforming to the action of the muscular coat. Between the rugæ of the mucous membrane in the course of the curvatures, by the aid of a microscope may be seen several little openings, formed by the excretory ducts, of small mucous glands, which are placed in the cellular membrane external to the mucous coat; these glands are termed the "Glandulæ Brunnerii:" there are also numerous other small perforations found on the mucous surface of the stomach, particularly about its two orifices, which are the openings of Peyer's follicles. The whole inner surface of this coat is covered with an abundant viscid secretion, as well as that peculiar solvent fluid which is termed the gastric juice. The entrance of the œsophagus and pyloric opening should now be carefully examined; for it will be found, when speaking of the process of chymification, that the functions of the stomach depend much upon these orifices being closed; for which purpose we shall find a peculiar construction. The œsophageal or cardiac orifice is situated at the left extremity of the smaller curvature of the stomach, at the junction of the two right with the left third of the upper portion of that viscus; the large *cul de sac* formed by the splenic extremity of the stomach, being entirely to its left. The termination of the œsophagus into the stomach does not form a circular opening, but an orifice, directed obliquely forwards and slightly to the left; so that if a transverse section were made of the stomach, the anterior half of the organ would retain three-fourths of the œsophageal orifice; which arrangement tends to prevent regurgitation of the food, and offers a greater obstacle as the stomach changes its position, when thrust forwards from the accumulation of food. This cardiac opening is placed to the left of the tenth dorsal vertebra.

The pyloric orifice is produced by the termination of the stomach into the duodenum, at the junction of the scrobiculus cordis with the right hypochondriac region, immediately to the right of the twelfth dorsal vertebra. This end of the stomach becomes more and more contracted as it approaches the duodenum, and forms a conical extremity which enters the intestine, the commencement of which envelopes the apex of the pylorus. At this point the pylorus is contracted by a circular rim, which is flattened and perpendicular to the walls of the orifice, and has been termed by some anatomists, the valve, and by others the muscle of the pylorus. It is of a whitish color, and four times the thickness of the muscular coat of the stomach, it appears to possess a remarkable power of resisting the passage of aliment from the stomach, until it has undergone the changes produced by the process of chymification. The position of the stomach, in its distended state, may offer some resistance to the free passage of its contents, but does not appear to be the sole cause of its retention; which is verified by the following experiment:—When the stomach of a living animal is dilated with air from the œsophagus, it will suffer considerable distention before the air passes through the pylorus: on the contrary, air passes readily when blown in from the duodenum. Whether this power is attributable wholly to position, or depends upon the muscular contraction of the valve, appears to be a subject fully worthy of further research.

Organization of the duodenum.—The duodenum is larger, thicker, and capable of greater distention, than the other small intestines. As before observed, it is only partially covered with peritoneum, to which this greater distensibility is attributable; and which has led some authors to consider it, as a second, or subsidiary stomach. The fact, that when food has passed from the stomach not perfectly chymified will be returned through the pylorus, would seem to point out a power in the duodenum, which places the digestive apparatus of man, an omniverous feeder, as a link between the most complicated structure of the ruminating, and the more simple apparatus of the carniverous animals.

The *peritoneal coat,* gives a covering to both surfaces of the upper transverse third of the duodenum, and only an anterior covering to the middle, vertical, and inferior transverse third.

The *muscular coat,* is formed of strong fibres passing principally in a circular direction, although some few longitudinal fibres may be observed on its superior transverse portion.

The duodenum should now be cut open on its upper surface, to expose its internal *mucous coat;* which is a continuation of that from the stomach. It is reddish, soft, and presents innumerable villi, around which there are openings from the mucous follicles placed within the cellular membrane connecting the mucous with the muscular coat; these follicular openings are more distinct here than in the stomach. The mucous membrane of the duodenum presents a very extensive surface, disposed in numerous folds lying one over the other; these are called the valvulæ conniventes: which not only retard the quick passage of the food through the intestine, but are for the purpose of presenting a larger absorbent surface, or distribution of the lacteals. At the point of union of the vertical with the lower transverse third of the duodenum, a small tubercle or papilla perforates the mucous membrane, for the common termination of the biliary and pancreatic ducts, which renders the duodenum a most important part of the alimentary canal.

The *arteries* of the duodenum, are derived from the hepatic branch of the cœliac; from the pyloric, right inferior gastric, and superior mesenteric. Its *veins* correspond with the arteries: the *nerves* are distributed from the solar plexus: its *absorbents* pass to the ganglia situated immediately above the pancreas.

The importance of the secretions furnished from the chylopoetic viscera, and the remaining portion of the intestinal canal being subservient to their united actions, it seems more consistent with the physiology of digestion, to describe the liver, pancreas, and spleen, next to the duodenum.

Organization of the liver.—The relative position of this organ within the cavity of the abdomen having already been described, we may at once proceed to give an account of its structure. This is the largest of the glands; its weight, in the adult, is about four pounds, or one-sixteenth of the whole weight of the body; in the fœtus, however, it bears a much greater proportion. The liver is of a deep red, or brown color; compact in its texture, but easily torn when its peritoneal covering is removed: it presents an irregular quadrilateral figure, in which we distinguish a *superior convex surface,* an *inferior irregularly concave surface,* a *posterior obtuse,* an *anterior acute edge,* and *two lateral edges,* the right of which is the more obtuse. The superior convex surface is divided into two unequal halves by the suspensory ligament, which we have already described as formed by a duplicature of the peritoneum serving to connect the liver to the diaphragm. The right larger half is termed the *right lobe,*—on the surface of which nothing is presented worthy of remark, beyond its general convexity; the *left* side, or *smaller lobe,* presents less convexity, and is directed rather more upwards than the right. The under concave surface, in a like manner to the superior, is divided into a large right and a small left lobe, the division being marked by a deep fissure, which passes in the short diameter of the organ from before to behind. The concavity is irregular, and does not correspond to the convexity of the superior surface. On the concave surface of the right lobe are distinguished three elevations, of the substance of the gland;

termed, lobulus spigelii, lobulus caudatus, and lobulus quadratus.

The *lobulus spigelii*, somewhat of an oblong figure, is situated at the inner and back part of the right lobe; it is placed between the vena cava on its right side, and the remains of the ductus venosus on its left: at the posterior part it forms a portion of the obtuse edge of the liver, and at its lower anterior part it is bounded by the porta or transverse fissure.

The *lobulus caudatus*, is a projected elevation, which passes from the anterior extremity of the lobulus spigelii diagonally forwards, and to the right, and is lost in the substance of the right lobe; in this passage, it forms a boundary to the porta of the liver.

The fifth lobe, or *lobulus quadratus*, is that portion of the right lobe of the liver which is placed between the gall bladder and the anterior half of the longitudinal fissure, having the porta behind it; while, anteriorly, this lobe forms a part of the acute edge of the gland. Sometimes a portion of greater or less extent passes from this lobe across the longitudinal fissure, to be connected with the left lobe, and forms what is termed the pons hepatis.

Fissures of the liver.—The first is the *longitudinal*, which divides, as before mentioned, the lower surface of the liver into two unequal lobes, extending from the anterior to the posterior edge in its short axis. This fissure may further be divided into two, at the point where it crosses the left extremity of the porta at right angles. The anterior half may be termed the *umbilical fissure*, from its containing the remains of the umbilical vein; while the posterior half may be termed the *fissura venosa*, from its containing the remains of the sinus venosus.

The *transverse fissure*, forms the porta of the liver, which passes in its long axis from side to side, and is placed about the centre of the organ: it is bounded behind, by the lobulus spigelii; before, by the lobulus quadratus; on the right, by the lobulus caudatus; and on the left, by the longitudinal fissure. This fissure is termed the porta, from its giving passage to the principal blood-vessels and the ducts of the liver, containing the same parts as are found in Glisson's capsule; namely, the hepatic arteries, hepatic ducts, and vena portæ. As the hepatic ducts pass out of the liver at the porta, they are placed between the artery and vein; but as the common duct passes forwards to the duodenum, as we have already observed, it is placed to the right of the artery and vein.

To the right of the lobulus spigelii, either a *fissure* or foramen is found for the passage of the vena cava; it passes in the direction of the short axis of the gland, and opens at the obtuse edge close to the diaphragm, through which this vessel passes to terminate in the right auricle of the heart. Immediately to the left of the vena cava, and superior to the lobulus spigelii, will be found the openings for the passage of the hepatic veins, which pass from the liver to terminate in the vena cava, at its passage through the diaphragm.

At the commencement of the longitudinal fissure, a notch may be seen upon the superior, as well as the inferior surface of the organ: this receives the round ligament, or remains of the umbilical vein, and forms the fifth *fissure* of the liver.

The under surface of the liver is further rendered irregular by numerous *depressions,* which seem as if they were produced by the pressure of the neighbouring organs. There are five of these, which may be principally distinguished: two upon the under surface of the right lobe; the one placed anteriorly to the other receives the colon, just where the ascending portion of that intestine becomes transverse; and the posterior depression is marked by the capsula renalis and right kidney. The left lobe has a similar depression for the descending colon, and another posterior to it for the large left extremity of the stomach and spleen.

A fifth depression is found immediately on the right of the lobus quadratus, of an oval form, which lodges the gall bladder; this depression is not covered by peritoneum, but is in contact with the parietes of the gall bladder.

The liver receives a general covering from the peritoneum, but is not completely surrounded by it in its whole extent; for at the posterior or obtuse edge there is a considerable space left between the two laminæ of this membrane, in which is found the vena cava and the terminations of the hepatic veins. A further use is attributable to this separation of the peritoneum, in allowing the liver to enlarge upon receiving an increased quantity of blood during the process of digestion.

The peritoneum covering the liver presents a transparent, smooth, and polished surface, which is constantly moistened with a serous fluid, and facilitates therefore the motions to which the organ is liable; it presents also a rough cellular surface, which is connected with the true cellular envelope of the organ. And further, the peritoneum not only gives this external covering to the liver, but forms several processes, which connect it with the diaphragm and parietes of the abdomen.

These processes are termed the *ligaments* of the liver, and are five in number. First, the round ligament, is the remains of the umbilical vein, which is found as an impervious cord running from the umbilicus, between the fascia transversalis and peritoneum, to the umbilical notch; and then proceeding along the longitudinal to the transverse fissure, is lost in the substance of the liver. The use of this cord after birth, may be considered principally for the purpose of attaching the liver to the parietes of the abdomen. Around this cord the peritoneum, as it passes from the convex surface of the left lobe, across to the right, winds around the round ligament; and then, being reflected upon the diaphragm, forms the *suspensory* ligament; — thus keeping the liver in its situation in the epigastric region. The suspensory ligament in its direction backwards, as it gains the obtuse edge of the liver, splits into two; or, more properly speaking, its two laminæ separate. At this point one is termed the *coronary* ligament, which passes right and left, from the obtuse edge of the liver to the diaphragm, and forms the superior layer of the right and left *lateral* ligaments; the other, or inferior layer, being completed by the peritoneum, which is reflected from the concave surface of the liver to the diaphragm: these layers are considerably separated from each other, and leave therefore, as has been before described, the obtuse edge of the liver uncovered by peritoneum. These five connecting membranes, or ligaments as they are called, seem to maintain the liver in the epigastric region.

Underneath the peritoneum a second envelope is found, surrounding every part of the liver, and entering even into its very substance, by accompanying the branches of the hepatic artery and vena portæ; and by some anatomists is considered to form an extension of membrane for the ramifications of the different vessels which enter into the composition of the organ, so indeed as to produce the principal part of its parenchyma. This membrane also surrounds the hepatic ducts, and where it encloses the vessels the sheaths receive the name of Glisson's capsule. It does not give the same covering to the hepatic veins; hence these vessels, when divided, do not collapse, being firmly attached to the substance of the liver, while the other vessels contract and recede within their cellular capsules.

Having in this description attended to the circumstance of different *vessels* entering into the liver, it is necessary more particularly to describe them, and to mention that there are five sets: namely, the vena portæ and the hepatic arteries, to convey blood to the organ; the hepatic ducts, to convey the secretion from it; the hepatic veins, to return the blood into the circulation which is not consumed either for the secretion of bile or nourishment of the liver; and lastly, the absorbent vessels, which are for the same purpose as in other parts of the body, to remove that which is unfitted for the natural function of the biliary apparatus.

The *vena portæ* is produced by the junction of the splenic and superior mesenteric veins, which form a trunk smaller than the united diameters of the two. It takes a course upwards and to the right, opposite to the junction of the last dorsal with the first lumbar vertebra; it then proceeds to the porta of the liver, and within the substance of the gland is distributed after the manner of an artery,—a circumstance in which it differs from every other vein in the body.

The *hepatic artery* is derived from the cæliac, after which it divides into a right and left trunk to be distributed to the respective lobes.

The *hepatic veins* arise from within the substance of the organ, form trunks which pass backwards towards the obtuse edge of the liver, where they pass out to terminate in the inferior cava.

The *hepatic ducts* form the excretory apparatus of the liver, and pass out, finally uniting in the transverse fissure; it reaches Glisson's capsule, through which it passes to the duodenum, receiving in this course the ductus cysticus of the gall bladder.

The *absorbent vessels* of the liver take two courses; one set terminates in the thoracic duct within the abdomen, the other perforates the diaphragm, ascending in the anterior mediastinum to enter the duct, near to its termination.

The student may here observe, that the liver has five lobes, five fissures, five depressions, five ligaments, and five sets of vessels.

The ultimate structure, or parenchyma of the liver, is to be observed by cutting into or breaking down the structure of the organ. It presents a granular surface, formed of minute kidney-shaped bodies, of a reddish yellow colour, being connected with each other by a brown cellular texture. From the innumerable ramifications of the blood-vessels and biliary ducts, the torn surface of the liver presents a cellular appearance. If a portion of the liver be kept in pyroligneous acid for about two months, this granular structure is rendered more evident; each small lobule will be separated, assuming various forms, generally resembling minute kidneys, having vessels connected to them in a sort of fissure, exactly resembling the kidney itself. The same appearances may sometimes be observed from the formation of tubercles, when they reach the surface of the gland, when these lobules become separated from their connecting cellular membrane. These little granules appear to receive the different sets of vessels distributed to the organ; but some difference has been observed in the mode of their intimate connection, upon which depends the function of the secretion of the bile. Let us first believe the granule as the proper glandular apparatus. To it we find blood supplied from two sources, namely, from the hepatic artery and vena portæ; the secreted product is conveyed from the granule by the hepatic duct, while the blood not exhausted either by the formation of the bile or nourishment of the liver, is conducted into the due course of the venous circulation by a branch of the hepatic vein. These are the facts observed in the minute structure; and without entering into the controversy of whether bile is furnished solely by the vena portæ, by the hepatic artery, by both, or by the particular action of the granule itself independent of either; it need only be observed, that the greater proportion of the principles constituting bile, is furnished by the vena portæ. It has long been, and is yet, a matter of controversy, whether the bile is furnished from materials supplied by the hepatic artery, or vena portæ: those who contend for the artery observe, that the proportion of secretion is in proportion to the quantity of blood supplied by the artery; and further, that the quantity of arterial blood is greater than would appear necessary for the mere nourishment of the gland itself: while those who contend for the vena portæ, dwell on the fact of the elements of the bile being found in the greatest abundance in the blood of the vein: at the same time it may be observed, that the vital energy of the portal ramifications must be very great, being plentifully supplied with nerves from the semilunar ganglia.

The secretion of bile, however, does not seem absolutely to depend upon the circulation of the vena portæ alone, from the fact of this vessel having been found to terminate occasionally in the vena cava inferior, when the supply of blood to the liver is solely derived from the hepatic artery, which in such instances has been invariably found of an unusually large size. When the hepatic ducts are tied, the liver becomes universally suffused with bile of a green hue; and ten hours after the experiment, matter is discharged from the anus of the same green tint. It seems therefore probable, that both artery and vein assist in the formation of the bile. The experiment of tying the vessels, and of throwing injections into them, proves an intimate connection between them, without furnishing any conclusive results. It seems, from the recent investigations of Dr. Mappes, of Frankfort, that the ultimate ramifications of both the vena portæ and hepatic artery meet in the little granules of the liver, and that the secretion is produced by these granules,—from which the radicals of the hepatic ducts arise. He further observes, that the hepatic artery and vena portæ appear rather to surround, than form an intimate visible connection with the granula; while, on the contrary, the hepatic vein is most intimately connected with the substance of the granule itself. He therefore concludes, that the hepatic vein has a principal office in effecting the separation of the bile; while the hepatic artery, and vena portæ, appear to perform a preparatory or conducting apparatus, previous to the elimination of the secretion by the proper vital action of the granule.

Besides the biliary ducts, the *gall bladder* is to be considered as part of the excretory apparatus of the bile, and as belonging to the liver, for the secretion of which it forms a reservoir. The gall bladder is an elongated pyriform pouch, which is connected with the anterior part of the right lobe of the liver, upon which a depression is formed to receive it. Its direction with respect to the short axis of the liver is not vertically, but obliquely placed, being directed forwards and to the right. As might be supposed from its pyramidal form, it presents an apex and a base, and the centre of the organ is distinguished by all anatomists as the body.

The *body* of the gall bladder adheres to the depression formed for it on the right lobe of the liver, by its cellular coat, as well as by the ramifications of blood-vessels; but no ducts, nor any medium of communication can be traced between them, although it was formerly believed that ducts led from the one organ to the other. The *base* of the gall bladder usually projects beyond the acute edge of the right lobe of the liver; and presents itself to view upon the cavity of the abdomen being laid open, lying in contact with the commencement of the duodenum, which is usually colored by its exuded bile. The *apex*, which forms the neck of the gall bladder, is directed upwards, backwards, and to the left towards the transverse fissure; is narrower and slightly curved to become connected with its excretory duct, which empties itself in the hepatic duct.

The gall bladder has its parietes formed of three coats,—a serous or peritoneal, a cellular, and a mucous.

The *serous* or peritoneal coat, is derived from the anterior layer of the less omentum, and does not give a covering to the whole organ; for the upper part of the body which is connected with the liver, is deficient in this membrane.

The *cellular* coat surrounds the whole of the gall bladder, and produces the adhesion between it and the liver upon the upper part of the body; while through the rest of its extent, it connects its serous and mucous coats. If quicksilver be insinuated into the cells of this coat, the absorbent vessels may be injected.

This coat has by some anatomists been considered as muscular; they having been led to this supposition from the adaptation of the viscus to its contents, as well as from the power which it has been suppossd to exert, upon the application of artificial stimuli.

The *mucous* coat forms the interior lining of the gall bladder, and its duct. It is of considerable thickness, and of a whitish color, though generally found tinged with bile soon after death. This coat is furnished, particularly about its neck, with numerous folds, which cross each other in various directions, having within them minute rugæ. Towards the neck and commencement of the cystic duct, these folds assume more of a valvular distribution, and have been described by Bichat as being arranged in a special direction. Upon the surface of this membrane are found numerous follicles, particularly about the neck; these probably secrete the mucus which is destined to defend the organ from the acrimony of the bile.

The gall bladder is not found in many animals possessing livers, as in the elephant, horse, rhinoceros, camel, certain cetacea, and some birds; it is found, however, generally in carnivorous feeders. Cuvier suggests, that its presence is connected with the necessity such animals have of fasting for a long time. In the human subject it is sometimes wanting, and in certain instances of calculi it has been found so filled with these concretions, as to be useless as a reservoir for bile: while, again, the ductus communis may be so pressed upon, as to prevent the discharge of bile into the duodenum; in which case, the gall bladder may become so distended, as to produce a prominent fluctuating tumour in the epigastrium. Instances have occurred in which these tumours have been opened, under the supposition of their containing matter; the result of which has been quickly fatal, from the escape of bile into the cavity of the abdomen. In other instances, the ductus cysticus only has been obstructed; when the gall bladder has been found filled with pure transparent mucus.

The union of the cystic with the hepatic duct, forms the ductus communis choledochus, which is about three inches long, passes between the lamina of the less omentum, in front of the hepatic arteries, which are placed between it and the vena portæ; it then descends behind the head of the pancreas and second portion of the duodenum, into which it enters, uniting with the pancreatic duct; passes between the coats of this intestine, and opens within it, an inch below its first entrance, at a small mamillary projection, which presents the appearance of a membranous valvular fold.

These ducts are composed of two coats; the outer, cellular, and similar to that of the gall bladder; the inner, mucous, and furnished with several rugæ of a semilunar form. These are supposed to contribute to retard the course of the bile. Some anatomists have considered that the opening of the ductus communis into the duodenum, is furnished with a small sphincter muscle, which regulates the proper flow of bile in the process of digestion.

Nerves and absorbent vessels may be traced surrounding these ducts.

The Pancreas

Is deeply seated in the epigastric region. It is a long narrow gland, passing transversely from the duodenum on the right side, to the spleen on the left; presenting a convexity anteriorly, and a concavity posteriorly. It is bounded *before*, by the stomach and less omentum; *behind*, by the aorta, superior mesenteric artery, and vena cava; and is opposite to the junction of the last dorsal with the first lumbar vertebra. Its *superior* edge is intersected by the cœliac artery, and on the left assists in forming a groove for the passage of the splenic vessels. Its *lower* edge corresponds to the inferior transverse portion of the duodenum, from which it is separated by the superior mesenteric artery. Its larger *right* extremity, or head, is thicker and broader than the *left;* and has a smaller portion of gland connected with it, which is sometimes called the small pancreas. These are placed within the curvatures of the duodenum, sometimes a little overlapping the middle or vertical portion. The left extremity, or tail, is thin and narrow, reaching beneath the spleen, with which it is connected by peritoneum, as far as the left capsula renalis. This organ occupies a portion of the three divisions of the epigastric region.

Organization.—Its anterior surface is covered with peritoneum. Its parenchyma is of a reddish grey color, composed of a number of small lobes connected by a dense cellular membrane, which gives it its peculiar firmness; each of these lobes are again divisible into minute granules, which give rise to the radicals of the excretory duct, and probably receive the ultimate termination of the arteries, and the origin of the veins. The excretory duct takes its course from the tail to the head, or from the left to the right, nearly in the centre of the substance of the gland, but somewhat nearer to its lower edge; being formed of the union of the minute branches, which are united with it in a penniform distribution. The duct increases in size as it approaches its termination; near which it is enlarged by the addition of a similar duct, which joins it from the less pancreas. It terminates at an acute angle in the ductus communis choledochus; or sometimes runs parallel with it, to open separately into the duodenum. Occasionally, though rarely, the less duct will also terminate separately.

The *duct* is composed of an internal smooth mucous membrane, covered by dense cellular tissue; it is more transparent than the excretory duct of the liver.

The *arteries* of the pancreas are very numerous, but of small size, and are distributed from the branches of the cæliac artery. Its veins terminate in the vena portæ, and particularly through the medium of the inferior mesenteric and splenic veins.

Its *nerves* are derived from the solar plexus, and its *absorbents* terminate in the pancreatic ganglia.

The size of the pancreas in the fœtus is not, as the liver, greater in proportion, but bears the relative dimensions of the rest of the body; in old subjects it becomes smaller, and of a darker color.

It is found of a large size in herbivorous feeders; and in different animals there is a considerable variety in the termination of its duct. This organ has been considered very similar to the salivary glands; but besides numerous anatomical distinctions, Tierdermann and Maling have discovered material analytical differences. They believe it to be the principal agent in chylification; while the bile only colors the chyle, and is principally for the use of decarbonizing the blood. There seems indeed every reason to believe it to perform some important part in the digestive process, not perhaps essentially necessary, but requisite for perfect digestion; it has been removed from the lower animals without causing any particular distress.

The Spleen

Is placed in the left hypochondriac region, behind the large left extremity of the stomach; it is bounded *above,* by the diaphragm; *below,* by the left capsula renalis, and descending colon: in *front,* by the stomach; on the *left,* by the ninth, tenth, and eleventh ribs, and origin of the diaphragm; and on the *right,* by the pancreas. Its form is ovoid, its long axis, which varies from four to six inches, is placed vertically; its *upper* extremity is smaller than the lower; its *outer* surface is convex, corresponding to the concavity of the diaphragm; its *inner* is irregularly concave, and is marked by a fissure, into which its vessels enter to be distributed in the substance of the organ. There are often deep fissures on the edges of the spleen, and sometimes one or more smaller spleens attached to the larger one.

The spleen is furnished with two envelopes, or coats,—the external serous, and the internal fibrous.

The *serous* or peritoneal coat, gives a general covering to the organ, excepting at the bottom of the fissure, from the edges of which it is reflected and continuous, forming the attachment of the spleen to the stomach and the diaphragm.

The *fibrous* coat, is much more extensive than its serous; for it not only covers the periphery of the organ, but enters minutely into its substance, of which it forms a very considerable part. It may be seen entering the bottom of the fissure, accompanying and surrounding the vessels. It is of a greyish white color, dense and elastic. Blood-vessels can be traced to it; but its nerves have not yet been demonstrated.

The human spleen presents, in the recent subject, a greyish blue color, but which in a few hours changes to a purple hue, so as to resemble a mass of clotted blood; and it has a somewhat shining appearance, produced by the dark purple substance underneath its external white coat. When divided, the clotted mass is seen to be held together by threads of a white fibrous tissue. Upon washing away the clotted substance, the fibrous portion resembles a soft fine sponge, so transparent, that it is best seen when floated in water.

The splenic *artery* takes its rise from the cœliac, runs along the posterior surface of the upper edge of the pancreas in a remarkable tortuous manner, which tortuosity admits of the motions of the spleen with the stomach and diaphragm; but the spleen also receives some small arterial branches from the diaphragmatic, capsular, first lumbar, and spermatic artery on the left side.

The accompanying *vein* is somewhat larger than the artery; it is remarkable for the thinness and extensibility of its parietes; and like the other abdominal veins, it is not furnished with valves. The splenic vein forms the principal branch of the vena portæ.

The *absorbent vessels* of the spleen are large, and easily injected; they are divided into a superficial and deep-seated set, surround the splenic vessels, and passing through the hepatic ganglia proceed to terminate with the absorbents of the liver in the thoracic duct.

The *nerves* are separated from the solar plexus, and are termed the splenic plexus.

There has been great difficulty in assigning the proper office of the spleen; but its situation, its plentiful supply of blood-vessels from the cœliac artery, the origin of its nerves, and its attachment to the stomach, all tend to induce the belief that it performs some important office connected with the process of digestion. Whatever this function may be, it appears one which may be compensated for by the action of other parts. I have extirpated the spleen from several animals, without observing any particular result, excepting in one instance, the omentum of a dog was particularly loaded with fat; and this animal, as well as several others, had a tendency to lose their hair, and had a mangy disposition in their skin. It may be worthy of remark, that rabbits subjected to this experiment seldom survive beyond a week or ten days; while dogs, with cautious feeding, seem to suffer but little inconvenience. May this in any way be connected with the difference of digestion between carnivorous and herbivorous feeders?

The termination of the splenic artery, and the commencement of its vein, have been variously described by different authors.

Some suppose the artery to terminate in cells, from which the veins arise. Others, that its minutest divisions terminate like the hairs of a pencil, without anastomosing with each other; around which the veins arise freely anastomosing. Its erectile power is attributed to this structure.

Sir Everard Home considers the spleen to be made up of an interlacement of arteries, veins, and absorbents, between which there is no cellular membrane, the interstices being filled with serum, and the coloring matter of the blood, which is poured out from the lateral orifices of the veins, when these vessels are in a distended state; and which serum is afterwards removed by the numerous absorbents belonging to the organ, and is carried into the thoracic duct by a very large trunk. He considers, therefore, the spleen to be a reservoir for the superabundant serum, lymph, globules, soluble mucus, and coloring matter of the blood, which is carried into the circulation immediately after the process of digestion.

Sir Astley Cooper for several years described the spleen, in his anatomical lectures at Guy's Hospital, as a reservoir for venous blood; possessing in itself the power of pouring its contents into the vena portæ by the inherent elasticity of its proper coat: and used to illustrate his opinion by distending the spleen with water, and then by puncturing the fibrous tunic, the fluid was forced out of the organ, forming a complete *jet d'eau*, until perfectly emptied.

Minute whitish bodies are dispersed numerously through the substance of the gland, the nature of which is unknown. The whole substance of the gland admits of minute injection, which is found to pass readily from the arteries into the veins.

What change the blood undergoes in the spleen, is unknown; but it has been observed, that the chyle in the thoracic duct, above the entrance of the absorbents of the spleen, differs from the chyle in the mesenteric absorbents, in its greater power of coagulation, and a closer resemblance to blood; from which it has been concluded, that this organ is essential to chylification. This view of its office is supported by the fact, that in the fœtus the spleen is small, at which time no chyle is found in the intestinal canal; whereas after birth, when the assimilation of alimentary matter commences, the viscus is found full of blood, and increases rapidly in size. A further corroboration of its use in assimilation, is derived from the circumstance of the spleen being found full of blood in animals which have been starved to death.

The pathology of the spleen has not afforded any light as to the nature of its function, although it is frequently found diseased, and particularly in protracted cases of intermittent fever.

We have next to give a particular account of the organization of the remaining portion of the intestinal canal. This consists of the jejunum and ileum, small intestines; and of the cæcum, colon, and rectum, forming the large intestines. For their relative position *vide p.* 39.

The *jejunum* and *ileum* constitute the greater length of the intestinal canal, and fill the greater part of the umbilical and hypogastric regions. Their division is arbitrary; but anatomists have assigned two-fifths of their length to the jejunum, and the remaining three fifths to the ileum: they are tied to the spine by that process of peritoneum which is termed mesentery. This process forms a bed for the distribution of the numerous vessels passing to and from the small intestines; and is so disposed as to allow of the frequent convolutions in which they are arranged. The small intestines are distinguished from the large by their general smooth and shining surface, and by their cylindrical form only being interrupted by the bendings of the convolutions. Like the stomach and the duodenum, they are composed of three coats. First, the *serous*, or peritoneal coat, which gives them a general outer covering, leaving a space between the two layers forming the mesentery, for the entrance of their vessels and nerves, and to allow of their distention. There is also found between the layers of the mesentery, numerous small glands, which are termed the mesenteric ganglia.

The *muscular* coat, is not so thick as in the duodenum; but is arranged in the same manner, in longitudinal and circular fibres. The *longitudinal* fibres are external, and most perceptible along the convex edge of the intestine. These fibres are not continued through the whole length of the intestine, but have frequent interruptions. The *circular*, or internal fibres, are more apparent than the external, are pale in color, and pass in a transverse direction; never, however, forming a complete circle, but, like the longitudinal, have frequent interruptions, from which fresh fibres commence.

The *mucous* or *villous* coat, is paler than in the stomach, and forms itself into numerous folds, which encircle about three-fourths of the calibre of the intestine; these are broader in their middle, pointed or bifid at their extremities, and are imperceptibly lost by uniting with other folds. These duplicatures are termed the valvulæ conniventes, and are found most numerous in the jejunum; their use is to afford an expanded surface for the distribution of the lacteals, and at the same time to arrest the progress of the aliment for the purpose of its absorption. On the surface of the valvulæ conniventes are found numerous little projections, forming fringes, which are composed of numerous villi; and if these be subjected to microscopic observation, numerous perforations are discovered, which are the absorbent mouths of the lacteals.

Between the muscular and mucous coat of the intestines, in the cellular membrane which connects the two, are numerous mucous follicles, which open into the intestine in the interstices between the valvulæ conniventes; they are in some situations found in clusters, particularly near the termination of the ileum, and are termed the glandulæ aggregatæ or Peyeri; in other situations they are larger and isolated, and are termed glandulæ solitariæ or Brunnerii; these latter are more distinct in the duodenum, and upper part of the jejunum.

The *arteries* of the jejunum and ileum are derived from the convexity of the superior mesenteric artery; they take their course between the folds of the mesentery, and are remarkable for their frequent anastomoses; fifteen to twenty branches are first given off separately from the convexity of the superior mesenteric; these again unite, so as to form smaller convexities, from which minuter branches are distributed, again forming the smallest convexities, which ultimately send the minutest branches into the intestines.

The *veins* take the course of the arteries, and terminate in the vena portæ.

The *lacteals*, which are more distinct and numerous above than below, take their course between the layers of the mesentery, pass through the mesenteric ganglia and on the right of the second lumbar vertebra, between the right crus of the diaphragm and aorta, ultimately to terminate in the thoracic duct.

The *nerves* which accompany these vessels to be distributed to the intestines, are derived from the superior mesenteric plexus.

The term jejunum, has been adopted from the circumstance of the first portion of the small intestines being frequently found empty; but the jejunum may also be distinguished from the ileum by the greater number of its valvulæ conniventes, and from its being somewhat thicker, particularly near the duodenum.

The ileum terminates in the colon, in a peculiar manner, which will be mentioned with the anatomy of that intestine.

The remaining portion of the intestinal canal, forms one-fifth of its whole length, and is called the large intestines; for the relative position of which, *vide page* 40. They have certain characters that readily distinguish them from the small: these are their size, the inequality of their surfaces produced by numerous sacculated projections, and by the appendices epiploicæ—which are portions of adeps enclosed between the layers of the peritoneal coat.

Organization of the cæcum.—This intestine may be at once distinguished by its commencing in a *cul de sac* or blind pouch, and by its vermiform appendix. Its peritoneal coat does not give it a general covering, but leaves a considerable space posteriorly where it rests upon the iliacus muscle. Sometimes, however, a complete meso-cæcum or envelope is found.

The *muscular* coat is formed externally of three longitudinal bands, which commence from the vermiform process, and take their course at about equal distances, along the sides and posterior surface of the intestine; they are shorter than the intestine itself, from whence results the sacculated or puckered appearance of the cæcum, as well as of the other large intestines.

The inner layer of the muscular coat is disposed much in the same manner as that of the small intestines.

The *mucous* membrane of the cæcum, is peculiar in having three distinct openings on its surface; one into the ileum, one into the vermiform process, and a third into the ascending colon. It presents some indistinct folds, which have been termed its valvulæ conniventes; its villosities also are much less apparent than those of the small intestines. The mucous follicles are very numerous, but isolated.

The valvular opening of the ileum into the cæcum, is produced by the mucous membrane and circular fibres of this small intestine projecting into the large. This junction forms nearly a right angle; consequently, the projection of the ileum into the cavity of the cæcum, presents an upper and an under fold; the superior being termed the ileo colic valve, and the inferior the ileo cæcal,—which latter is larger than the upper, in consequence of the slight obliquity of the entrance of the small intestine. This inferior fold prevents regurgitation from the cæcum; and the superior fold (which is placed more transversely), from the colon. These folds are united at their extremities; and from each junction or commissure, a prominent fold is continued round the inner surface of the cæcum, forming retinacula or frena; in consequence of which, distention of the cæcum tends to close the entrance into the ileum. The peritoneal and longitudinal fibres of the muscular coat of the ileum, are continued upon the parietes of the cæcum.

The *appendix vermiformis* is a narrow, slender tube, about the size of a goose quill, five inches long, and is given off from the cæcum, just below the ileum. It is loosely connected with the exterior of that intestine by a process of peritoneum. It is composed of coats, similar to the intestines: its mucous coat extends from the interior of the cæcum, has numerous follicular appendages, and is generally found full of mucus. Its particular use in the animal economy is wholly unknown. In the fœtus, it is comparatively larger than in the adult.

In an anatomical point of view, the *colon* has but little interest beyond what we have already described in its relative position; for which *vide page* 41. The organization of the colon is similar to that of the cæcum; and may be distinguished readily from the small intestines by its three longitudinal bands of muscular fibres, by its sacculated appearance, and by its appendices epiploicæ. It is smaller than the cæcum, and not much larger than the small intestines, but usually presents a larger appearance from distention by air,—a very common occurrence found in *post mortem* examinations. The *arteries* of the cæcum and colon, as far as the sigmoid flexion, are derived from the concavity of the superior mesenteric.

The *organization of the rectum.*—Considerable variety will be found in the structure of this intestine, from the office it has to perform in the function of defecation. Its outer or peritoneal coat surrounds only the upper third of the intestine, forming in that situation, the meso-rectum; in its middle third, the anterior surface only receives a peritoneal covering; while the lower third is destitute of the peritoneum. From the anterior surface of the middle third, the peritoneum is reflected from the bladder, in the male; and from the uterus, in the female: from distention of these organs, the peritoneum is raised from this portion of the intestine.

The *muscular* coat of the rectum is thicker than that of the other intestines, and the arrangement of its fibres presents a considerable difference. The external or longitudinal fibres gradually lose their distinct arrangement, in bands which are not to be traced beyond the two upper thirds. In the lower third the circular fibres predominate, and are of a redder color, and thicker as they approach the anus; where, completely surrounding the organ, they have been described by some anatomists as an inner sphincter.

The *mucous* membrane of the rectum is similar to that of the rest of the alimentary canal, having rugæ, follicles, and villosities; it has no valvulæ conniventes; but the mucous membrane is thrown into longitudinal wrinkles or columns, from ten to twelve in number, between which are several semilunar folds, presenting the appearance of laminæ. The openings of the follicles are also distinct and stand out, secreting a thick white mucus, which constantly lubricates the interior of the intestine. Immediately above the sphincter of the anus the rectum is much dilated, and is surrounded by a quantity of cellular membrane, destitute of adeps, admitting of considerable distention under the accumulation of the fæces, until a convenient opportunity offers for its expulsion.

The *arteries* of the rectum are very numerous, and its principal branches are derived from the inferior mesenteric above, from the internal iliac in the middle, and from the internal pudic below; these constitute the hæmorrhoidal vessels.

The *veins* correspond to the branches of the arteries; they are large, form numerous communications, and are subject to great distention, producing the disease termed hæmorrhoids.

Its *nerves* are derived from two sources: from the lumbar plexus, whence its voluntary power; and from the hypogastric plexus, which maintains its involuntary peristaltic action.

The *absorbents* of the rectum terminate in the lumbar and hypogastric ganglia, and in a few absorbent glands placed between the layers of the meso-rectum.

Function of Digestion.

Having now considered the relative position and intimate structure of the alimentary canal, and its assistant chylopoetic viscera, we shall now proceed to the consideration of the important function of digestion these various structures are destined to perform.

The constant necessity of a supply of food for the support of animal life, is experienced in the sensations of hunger and thirst. The more immediate cause of these sensations, has not been clearly ascertained: they have been referred to the stimuli of certain secretions acting upon the coats of the stomach, mouth, and fauces; to the craving which habit creates when it remains ungratified; and to a certain nervous influence resident in the mucous membranes themselves. Whatever the cause may be, it instinctively leads us to seek both solid and liquid food. The food of man, is both animal and vegetable; which he submits to the sense of taste, particularly resident in the tongue and mouth; and which affords him pleasure or disgust, according as it is agreeably or disagreeably acted upon by its peculiar quality. The process of digestion is one of the most important, as well as complicated, of all the animal functions. It is a function common to all animals; by which substances extraneous to them are introduced into their bodies, and subjected to the action of a peculiar system of organs,—their qualities altered, and new compounds formed, fitted to their nourishment and growth.

Great attention has been paid to every phenomenon attendant upon digestion, without, however, unveiling the mystery concealed in this wonderful result of vitality. In order to elicit truth, it is certainly necessary to remark minutiæ, but this may be carried too far; as, for instance, by those physiologists who commence the history of this process with the movements of the upper extremity, in order to introduce portions of food into the mouth; and again, that the mouth must be opened to receive it. I shall, however, content myself by considering digestion under the heads of mastication, deglutition, chymification, chylification, excrementition, and expulsion or defecation.

Mastication.

The first process of digestion consists in the mastication, or grinding down of the food by the motions of the lower jaw, and its mixture with the saliva abundantly secreted by glands, placed for this purpose into the mouth*. At the same time, the masticated mass acquires a certain degree of temperature, which is generally equal to that of the blood; while the saliva, by its solvent power, predisposes the food for the future changes it has to undergo. Such substances as are not capable of being dissolved by the saliva, do not appear to excite the sense of taste, and probably are not capable of being assimilated.

This first process has been termed insalivation, as well as mastication; but their simultaneous actions are, in fact, but parts of one process.

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* The minute structure of the salivary apparatus will be given when speaking of the sense of taste.

The saliva is a clear limpid viscid fluid, without taste or smell; its specific gravity is 1·0038; and from the quantity in which it is secreted, it necessarily performs a most important office in the process of digestion.

According to Berzelius, it consists of—

Water	992·9
Peculiar animal matter	2·9
Mucus—albumen of Bostock	1·4
Alkaline muriates	1·7
Lactate of soda and animal matter	0·9
Pure soda	0·2
	1000·0

It has a strong affinity for oxygen, and froths upon being mixed with it, absorbing it readily from the air, and as readily parting with it to other bodies; hence gold or silver may be oxydized when triturated with it; trituration is necessary to mix it with water.

It is not improbable, as remarked by Richerand, that azote may be absorbed, as well as oxygen, during the process of mastication, for the purposes of the animal economy. The saliva may be much altered by disease, as may be seen in the deranged digestion in consequence of the influence of mercury. In a case of obstinate venereal, oxalic acid has been detected in this fluid.

Deglutition.

The process of mastication being completed, deglutition is the next function to be performed. The first step of which, is produced by the tongue collecting the masticated food in the form of a bolus, which this organ, by the various actions of its muscular fibres, throws backwards upon the uvula; and immediately the muscles of the fauces and soft palate are put in action, the anterior and posterior pillars of the fauces press the food backwards towards the pharynx; while the soft palate, becoming raised and straitened, prevents the food from passing either into the nostrils, or the eustachian tubes; and is therefore, by the elevation of the tongue, and still continued action of the pillars of the fauces, pressed backwards into the pharynx. During this muscular action, in consequence of the posterior pillars of the fauces being fixed to the thyroid cartilage, the larynx and pharynx are necessarily raised; by the former, the glottis is closed, the epiglottis being pressed against the tongue; while by the latter, the elevation of the pharynx places it in the best possible situation to receive the food, which is lubricated by the mucus belonging to these parts, as well as by the secretion pressed from the tonsils, by the action of the pillars of the fauces. When the mass arrives on the upper constrictor of the pharynx, that muscle contracts, pressing it downwards to the middle constrictor, which, in a similar manner, delivers it to the inferior constrictor; it then enters the œsophagus, which, by its longitudinal fibres shortening the organ, and the circular fibres contracting on the food, a vermicular motion is produced, conveying the masticated mass into the stomach. During its passage along the pharynx and œsophagus, it is further lubricated by the mucus from those surfaces.

Chymification.

As the food accumulates within the stomach, it is submitted to the action of the gastric juice, a fluid secreted by the mucous membrane; the result of which, is the change of the masticated mass into a homogeneous pulpy substance, called chyme. This process, from certain osbervations on living animals, appears to be effected in the following manner:—The food received into the cardiac extremity of the stomach, is principally there confined by a muscular contraction, about one third from the pyloric extremity; and is moved by a vermicular contraction of the muscular coat, which in some animals appears to give a rotatory movement. The surface of the mass is first changed into chyme; and as it forms, is gradually rolled off to the pyloric extremity, where it remains until admitted into the duodenum. It appears, that the peristaltic motions of the stomach and intestines commence in the duodenum, gradually extending from thence to the coats of the stomach; then an opposite vermicular motion is set up, at intervals, in the stomach, and is continued over the pylorus to the duodenum, pressing the chyme forward before it.

The chyme thus formed by the action of the gastric juice in the stomach, is of an acidulous flavour: and it is remarkable, that from whatever food it is produced, this is the case. From the experiments of Tiedemann and Gmelin, it was found, that the fluid secreted in the stomach without food, was clear and viscid, and did not contain any perceptible acidity; but immediately the coats of the stomach were stimulated by food, it became acid. *(Ed: Med: Journal.* No. XCIII.*)* The acid thus generated, Dr. Prout found to be muriatic, both free and in combination with alkalies. *(Phil: Trans:* 1824. *p.* 48.*)*

Many theories have been advanced to account for the changes produced upon the food in the stomach,—concoction, fermentation, putrefaction, trituration and maceration, have each had its partisans; while numerous experiments have from time to time been made, without, however, removing that obscurity in which the subject is still involved. The change produced in the masticated food, is not reducible to any of the known laws of chemical or mechanical philosophy. It resembles the action of chemical re-agents, but with this essential difference,—each change produced is modified by its connection with vital influence. Although Spalanzani positively asserts that the gastric juice, assisted by heat, will exert its solvent powers out of the body, it is not with the same energy as when in connection with a vital function, and loses this power after a short space of time: it is however, doubtful, whether or not these artificial digestions, as they have been called, possess any analogy to chymification; from recent experiments by M. T. Montegre, it appears they have not. Heat has been supposed to be a necessary auxiliary in digestion. Hunter, however, in his animal economy observes, that heat can only be a remote cause; for digestion goes on equally well in fishes, whose natural temperature seldom exceeds 50°, as in man, whose heat is 98°. The process is suspended in torpid animals at the temperature of 30°.

A great variety of experiments have also been made, by submitting different substances to the action of the gastric juice, in order to ascertain the changes produced. The result appears to amount to this:—that the general action of chymification consists in converting the substances submitted to the action of the stomach, more or less, to the nature of albumen. Every animal substance undergoes this remarkable change, excepting albumen, which remains unaltered when submitted to the action of the gastric juice. Albumen will pass the pylorus more rapidly than any other aliment.

Fluids appear to be acted upon by being absorbed or imbibed. M. Magendie tied the pylorus in a living animal, and found the absorption of fluids little if at all impeded. The same occurs with various medicinal substances. This subject is also involved in considerable mystery; for dissection has not yet enabled us to prove that the absorbents form the direct route of the fluids from the stomach to the kidneys; while it has been conjectured, that some short course exists, from the great readiness of their passage from one organ to the other.

No material fact has ever been elicited from the experiments relative to nervous influence. Division of the pneumo-gastric nerves merely retards the process of chymification; in the same manner as narcotics, administered so as to produce coma, or injuries of the brain affect the stomach by diminishing the amount of nervous influence transmitted to it. It has been ascertained, however, that after the division of the *par vagum*, chymification is retarded; and that the chyme itself when formed, is destitute of its natural acid qualities, and is become alkaline: but if the truncated nerve be made the medium of a galvanic influence, the acid qualities will be produced.

The gastric juice is neither acid nor alkaline; it possesses a peculiar solvent power, combining with the food taken into the stomach so intimately, as to change its nature. It is antiseptic, suspending the putrefaction of animal substances, whence it has been used with success as an application to foul ulcers. Its solvent power is not equally active on all substances; in some its action is resisted, as by the parietes of the living stomach, vermes, stones of fruit, seeds, &c. Its composition resembles the saliva, but from the difficulty in obtaining it pure, very little is known of its analysis. Magendie relates an analysis by M. Chevreul thus:—"Much water, considerable mucus, some lactic acid combined with animal matter soluble in water, and insoluble in alcohol; a little hydrochlorate of ammonia, and hydrochlorate of potass, and a certain quantity of hydrochlorate of soda."—*Vide* Milligan's translation of "Magendie's Elements of Physiology;" p. 168. Such a vague analysis is scarcely worth mentioning, excepting to shew how little is known respecting it.

Chyme has been frequently analyzed; but there is every reason to suppose, that its nature varies with the quality, and quantity of food, as well as the state of health of the individual: from whence the results are extremely uncertain.

Chyme formed from vegetable and animal food, has been analyzed by Dr. Prout, and affords the following results:—

Vegetable Food.		*Animal Food.*	
Water	88·5	Water	80·0
Chyme, &c.	6·0	Chyme, &c.	15·8
Biliary principle	1·6	Albuminous matter	1·3
Vegetable gluten	5·0	Biliary principle	1·7
Saline matter	0·7	Saline matters	0·7
Insoluble residuum	0·2	Insoluble residuum	0·5
	100·0		100·0

The time which a meal takes to be converted into chyme, is supposed to be about four hours; but this varies according to the nature of the food.

While digestion is going on, the openings of the stomach are closed against the regurgitation of the food into the pylorus; the escape of gas is owing to imperfect digestion. In many, a slight shivering is felt, the pulse is quickened; and in delicate women, the insensible perspiration is increased, so as to resemble a paroxysm of fever. The food is submitted to the action of the gastric juices by continued muscular movements; it does not, however, leave the stomach in the same order as it enters. The pylorus has a delicate sensibility, and closes against such portions of food as are not in a fit state to pass; and it possesses a sort of discriminating faculty, whence its name: thus, a substance not capable of being acted upon by the gastric juice, it allows to pass with the more perfectly chymified food; and should this be of a nature to injure the coats of the intestines, it will be covered with thick mucus to guard it from any asperity of surface which might occasion injury. From experiments tried upon living animals it has been found, also, that substances capable of further chymification having passed into the duodenum, will be forced back again into the stomach to be submitted to its further action.

Various causes will retard the process of digestion; among which, are imperfect mastication, sedentary habit, violent mental emotions, violent exercises immediately after eating, the recumbent position on the left side, and improper food: on the contrary, gentle exercise appears to promote the process, particularly in the process of the aliment through the intestines. Ease, and cheerfulness of mind, also promote digestion; as well as the general healthy actions of the whole system.

At times the stomach rejects its contents, by a convulsive action called vomiting; in this, the peristaltic motions are inverted, the muscles of the abdomen are excited by a spasmodic sympathy; they then contract, forcing the viscera upwards and backwards,—the diaphragm rising into the thorax: the pressure thus produced on the organ forces its contents into the œsophagus,—the pylorus at the same time offering a corresponding resistance.

Vomiting may arise from disease of the stomach itself, or from sympathy with other organs, or from sympathy in diseases; as may be seen in the effects of poisons, of injuries to the head, and the commencement of fevers.

Chylification.

The next process of digestion consists in the conversion of chyme into chyle; which process commences in the small intestines, and appears to be the result of the admixture of the bile, pancreatic juice, and mucous secretions with the chyme in the duodenum. This change is equally if not more essential than that produced in the stomach, which in some measure is subservient though previous to it. It is in the duodenum that the food is first separated into two ultimate formations, namely, nutritious and excrementitious substances: for which important purpose, every thing tends to retard the progress of the food in the duodenum,—its curvatures, its numerous valves, its extensive power of dilatation, the thickness of its coats (compared with the rest of the small intestines), and the numerous chylous vessels which arise from it.

The ducts of the liver and pancreas open into it; the bile does not flow in a continued stream, but at intervals of about twice in a minute; a drop exudes, which is diffused with the pancreatic juice in the chyme. The effect of this mixture, is shortly to separate the chyme into two portions; the one a whitish, tenacious liquid, termed chyle,—the other a yellow, pulpy, excrementitious matter. The former of these is absorbed by the numerous villi, as it slowly passes along the intestines; while the latter proceeds, undergoing however still farther changes before it reaches the rectum, from whence it is finally expelled. As the chyle passes along the small intestines, it gradually looses its acid qualities; the albumen also decreasing in quantity from the duodenum downwards.

Before we trace the aliment in its progress along the small and large intestines, and the further change it is in that progress destined to undergo, it will be necessary to take a particular view of the secretions which have been added to it by the liver and pancreas.

Of the *bile,* and its uses as an agent in the process of chylification, various conflicting opinions are entertained; the following appears to be most worthy of notice. As the liver, in all red-blooded animals, is placed so as to discharge its secretions, at the commencement of the small intestines, and before the separation of the nutritious from the excrementitious part of the aliment; it is presumed, that a principal object of the bile is, to effect the change of chyle into chyme. It has also, no doubt, other very important purposes to perform.

When the ductus communis choledochus has been tied in a dog, the thoracic duct will still be found filled with fluid, differing from chyle only in color; at the same time, the fæces are found white in color, of a peculiarly fœtid odour, with a high degree of putrescency. Hence it has been concluded, that the bile has a tendency to prevent the putrefaction of the food during its course through the intestines; and that it further excites the flow of the follicular secretions, by which the fæces are prevented from acquiring too dry a state. This latter property has been deduced from the observation, that the fæces of jaundiced persons are invariably in a dry hardened state.

The various substances contained in the bile, consisting as they do of such highly azotised principles, it is not improbable that it contributes to animalize those articles of food which are deficient in the quantity of azote they contain, It has also been observed, that the bile has a peculiar power of decomposing fatty substances; which Professor Tiedemann and Gmelin consider the sole agency of the bile in chymification. The white color of the chyme depends on the fatty matters dissolved in the food; for when formed from food destitute of fat or oil, the white color does not exist.

The most probable additional office assigned to the secretion of the liver, is that of forming an important excrement from the blood itself. From the experiments of Malphigi and Simon we learn, that all the principles of the bile are thrown out of the system with the excrements; and they observe, that in case of biliary obstructions, they are diffused in the cellular tissue, or escape by the urine. These principles contain a great proportion of carbon, and probably, therefore, tend greatly to decarbonize the blood. In herbivorous animals, whose food abounds in carbon, the resin of the bile is found in abundance. Hence the liver throws off carbon by uniting it to hydrogen, forming resin; while, in the lungs, it is thrown out in union with oxygen. Thus it is found that, in various animals, the size of the liver and the quantity of the bile is not in proportion to the quantity of food eaten, but in proportion to the size and perfection of the lungs: and what is still more to the point, more venous blood is sent through the livers of those animals which have small or imperfect lungs. Thus in birds and fishes, the vena portæ receive, in addition, the renal veins, and those of the genital organs; in serpents, those also from the intercostal veins. In the fœtus, the liver is much larger in proportion to that of the adult, and is much more abundant in its secretion of bile; which is seen in the frequent occurrence of jaundice at birth, and the quantity of bile found in the meconium in the latter months of gestation.

This office is further established by a multitude of pathological facts. In pneumonia and phthysis, the liver is frequently superabundant in its secretion of bile; in the morbus ceruleus, it retains its fœtal proportions; in diseases of the heart, the liver is enlarged; in hot climates it is also enlarged, owing to the abundant call upon its particular office from the great rarefaction of the air, which tends to lessen the perfection of the function of the lungs.

Finally, during the hybernation of certain mammalia, when respiration is suspended, and no food is taken in, the secretion of bile goes on.

Human bile differs from that of all other animals. Its color varies from a green, to a yellowish brown; and sometimes it is nearly in a colorless state. All the acids decompose human bile, precipitating albumen and resin copiously.

The appearance of the bile is different when taken from the gall bladder, in which it is always bitter, pungent, and viscid, from what it is when taken from the hepatic duct, during chylification. It then passes directly from the liver to the intestines, and is bland and harmless. Hence it has been supposed, that the ductus cysticus acts as an absorbent, selecting the more active principles of the bile to be detained in the gall bladder until required in the process of digestion; where it acts as a gentle purge, stimulating the follicular and other secretions.

Berzelius gives the following analysis:—

Water	908 · 4
Picromel	80 · 0
Albumen	3 · 0
Soda	4 · 1
Phosphate of lime	0 · 1
Common salt	3 · 4
Phosphate of soda, with some lime	1 · 0
	1000 · 0

According to the French chymists, the constituents of bile are mucus, albumen, ozmazome, gliadine, caseïn, picromel, asparagin, acetic acid, oleïc acid, margaric acid, cholic acid, resin, and coloring matter; but some of these, I question, with Brande, whether they are to be considered as products or educts. It may be said of the bile, that it is at once watery, albuminous, oily, alkaline, and saline.

We may, therefore, conclude, from these considerations, as well as from the fact, that bile poured upon chyme, out of the body, will effect the separation of the chyle from the chyme, that the secretion of the liver is not only essential to complete chylification, but it performs an important excretion from the blood itself, by abstracting carbon; and that it further prevents too great a putrefactive process in the excrement, and stimulates the intestines to induce the passage of their contents.

Of the *pancreatic juice*, which flows into the duodenum with the bile, very little is known, more than its general resemblance to saliva. Tiedemann and Gmelin state that the pancreatic fluid contains a large proportion of highly azotised principles, namely, albumen, caseïn, ozmazome, and a matter which is turned red by chlorine. Besides the bile and pancreatic juices, a quantity of mucus is secreted in the duodenum, which mixes with the aliment, and is subservient to the healthy process of digestion.

Excrementition.

The food in its passage along the small intestines continues to impart its nutritious particles, in the form of chyle, to the absorbents or lacteals, whose open mouths are every where numerously dispersed on the villi of the valvulæ conniventes, which for this purpose retard the progress of the aliment passing between their folds. The peristaltic action of the intestines promotes the passage of the food, in conjunction with an abundant mucous secretion, chiefly of an excrementitious nature, which lubricates the passing substances; this peristaltic action does not continue in a regular succession from the stomach to the cæcum, but shews itself at several points at once, and is probably excited by the stimulating qualities of the aliment.

Having traced the progress of the aliment through the small intestines, and considered the properties of the several secretions added to it in its course, we have now to consider its further progress through the large intestines. When the aliment obtains an entrance into the cæcum, it is called excremental or fæcal; at this point the fæcal matter has lost its acid qualities, but acquires acidity again in the large intestines.

The situation and peculiar structure of the cæcum, its great capacity, and the slow motion of the aliments, having to ascend contrary to their gravity, have induced a belief that in this viscus a new process of digestion is set up, analogous to that performed in the stomach, for the purpose of extracting those portions of nutrition which have not been separated in the stomach and small intestines; for this purpose Tiedemann and Gmelin consider the large follicles in the cæcum are destined, and that they secrete an albuminous, acid, solvent fluid, which, in like manner to the gastric juice, mixes intimately with the aliments poured in from the ileum; certain it is, that nourishment is obtained from substances thrown in by injection, but it has not been ascertained how far injections per anum reach along the bowels.

In the cæcum the first process of fæcation commences, and the excrement begins to assume its peculiar feculent odour: this odour is supposed to be derived from a volatile oil secreted in the cæcum; an hydro sulphurated gas is also separated,—more abundantly in debilitated persons, and under circumstances of disease.

The fæcal mass is composed of the residue of the aliments and of the excrementitious parts of the secretions of the digestive canal.

Berzelius gives the following analysis:—

Water	73·3
Vegetable and animal remains	7·0
Bile	0·9
Albumen	0·9
Peculiar extractive matter	2·7
Slimy matter, consisting of picromel, peculiar animal matter, and insoluble residue	14·0
Salts	1·2
	100·0

Expulsion.

As the excrementitious mass reaches the rectum it continues to increase in hardness, and to acquire a peculiar fetor. In the rectum its presence proves a stimulus to the muscular fibres of the part, in which all the muscles of the abdomen more or less participate; hence arises that desire, and the consequent efforts, which finally effect the act of expulsion.

In the examination of the contents of the stomach and the intestinal canal, we have yet to mention the different gases which are generally met with; the principal difference consists in the presence of oxygen in the stomach, and which probably is absorbed and conveyed into the circulation before it reaches the intestinal canal.

The gases found in four executed criminals, examined in Paris, were as follow:—

In the stomach—oxygen, carbonic acid, hydrogen, and azote.

In the small intestines—carbonic acid, hydrogen, and azote.

In the large intestines—carbonic acid, hydrogen, carbureted hydrogen, and azote.

In the rectum—carbonic acid, carbureted hydrogen, and azote.

LECTURE XXIV.

OF THE ABDOMEN AND ITS CONTENTS.

THE second class of organs contained within the cavity of the abdomen, are those which perform the function of the secretion and excretion of urine: they consist of the capsulæ renales, kidneys, ureters, bladder, and urethra.

The *capsulæ renales,* are two small bodies, having the appearance of glands, placed within the lumbar region of the abdomen, behind the peritoneum, above the kidneys, of which they embrace the superior and inner extremities.

They are held in their situation by a quantity of cellular membrane, containing adeps and numerous vessels, which are most obvious between the kidneys, and the renal capsules at their upper part.

The capsulæ renales present an irregular triangular figure, their broader surface being directed towards the kidney; they are of a brownish yellow color externally, and of a deep red brown internally, in the adult; but in the fœtus, are more inclined to a red.

The anterior surfaces of the capsulæ renales, are differently bounded on the right and left side. On the *right* side, by the duodenum, liver, and the ascending cava; on the *left* side, by the spleen and pancreas. Both of them *above,* are bounded by the diaphragm, and that on the right side, by the liver; *below,* by the kidneys; and *behind,* by the psoæ muscles, on which they rest. The left capsula renalis is rather higher than the right, corresponding with the position of the kidney, and is placed upon a level with the eleventh dorsal vertebra.

Each capsula renalis contains a cavity, in form somewhat corresponding to its exterior walls, is therefore of a triangular shape, and has a slightly elevated ridge or crest upon its lower surface. It contains a viscid, albuminous secretion, abundant in the fœtus, and of a yellow color; in adults and old people it is less abundant, and of a brown color. The substance of this organ presents a granulated or lobular appearance in the fœtus, which appearance becomes less perceptible at the adult period. Its structure is composed of numerous vessels, united by a strong cellular tissue, which is more dense towards the exterior than in the interior substance of the organ. Some anatomists have described the capsulæ renales as being made of a parenchyma composed of minute lobes, divisible into minuter lobules; but upon further inspection, it will be found that these apparent lobules may be unravelled, displaying a series of blood-vessels, the larger of which are the veins, connected by cellular membrane. Meckel denies that there is any internal cavity to this organ, and asserts that manipulation and spontaneous decomposition is the sole cause of this appearance. If however, the veins are injected, or even cut open as they enter the capsule, they will be found to enlarge, forming one principal cavity, which seems to have been mistaken for a closed bag within the organ.

The *arteries* are numerous, and are derived principally from three sources: *above*, from the diaphragmatic; *below*, from the emulgent; and in the *middle*, from the aorta. They ramify on the surface of the gland, and enter its substance by a multitude of minutely divided branches.

The *veins*, on the contrary, leave the organ in one or two large branches, more in the manner of a duct from its interior than as veins accompanying ordinary arterial distribution. This arrangement of vessels would lead one to suppose the vein is the true excretory duct, and that the capsulæ renales perform some office of assimilation to the blood immediately connected with the eliminating function of the kidneys. In the fœtus, these organs nearly equal the kidneys in size; and it is worthy of remark, also, that if they perform any office of assimilation to the blood, that their principal veins unite with the veins of the kidneys immediately after their exit from those organs, and together join the general circulation. In the fœtus the veins of the capsulæ renales are at least two-thirds the size of the ascending cava.

Their *nerves* are derived from the renal plexus.

Their *absorbents* terminate in the emulgent, and inferior diaphragmatic ganglia.

The Kidneys

Are complicated glands, being composed partly of structures which secrete, and partly of structures which excrete the urine.

They are situated in the posterior part of each lumbar region, lying on the diaphragm, psoas, and quadratus lumborum muscles; corresponding, in the direction of their long axis, to a space between the tenth dorsal and third lumbar vertebræ. They are situated behind the peritoneum, which adheres to them by loose cellular membrane; the right kidney is rather lower than the left, in consequence of the great size of the right lobe of the liver. Their figure is irregularly oval, presenting an anterior and posterior surface, a superior and an inferior extremity, an external and an internal edge. The *anterior surface* is convex, and covered entirely by peritoneum. The *posterior surface* is less convex than the anterior, is embedded in adeps, and has little or no covering from the peritoneum. The *superior extremity* is larger than the *inferior*, and is rather more inclined inwards towards the mesian line. The *external edge* is convex, and is directed outwards, and slightly backwards. The *internal edge* is formed by the rounded extremities turning inwards, leaving between them a fissure for the passage of the vessels and excretory duct of the gland; the fissure is of various depths in different subjects, and is more perceptible on the anterior than the posterior surface, in consequence of a projection of the substance of the gland which lies under the vessels. Considerable varieties exist in the form of the kidneys in different individuals, both in the fœtal and adult periods. In some subjects, they are united by a continuation of glandular structure passing across the spine from one kidney to the other; in others, they have been found three in number; and again, a single gland placed transversely on the spine. The volume of the kidneys generally, relatively to each other, as well as the number of their vessels, are subject to a similar extensive variety.

In the fœtus the kidney presents a lobulated appearance, being deeply indented between the lobes; but this is generally lost in the adult period, excepting close to the fissure, where they always remain more or less obvious.

Physiologists describe the kidneys to be comparatively large in the fœtus, smallest in old age, and intermediate in the adult.

Organization of the Kidney.—Besides the partial peritoneal covering, which is but loosely connected, the kidney has a cellular adipose capsule, and a proper strong fibrous tunic. The adipose capsule is thicker and most abundant on the posterior and external edge of the kidney.

The *proper fibrous tunic*, invests the whole external surface of the kidney, and dips into the fissure, accompanying the vessels, reaching as far as the infundibula, from whence it is reflected upon the external surface of its pelvis.

Before removing the kidneys to observe their minute structure, the relative position of their vessels should be examined.

The *artery* to each kidney is derived from the aorta; that of the right side is longer than on the left, and crosses behind the vena cava. The renal arteries in their course to the kidneys are placed between, their corresponding veins, which are in front of them, and the ureters, which are behind and below them.

The *veins* pass from the kidneys to terminate in the vena cava; that on the left side, which is the longest, crossing in front of the aorta.

The *excretory duct* or ureter, passes from the fissure behind and below both the artery and the vein, and makes an immediate turn downwards towards the bladder, as will be hereafter described in its connection with that organ.

The internal structure or substance of the kidney, is made up of two parts; one called the *cortical,* and the other the *mammillary* or tubular. The cortical is the most external, and is to be considered as the secreting portion of the organ, while the mammillary consists of the excretory apparatus.

The minute examination of the structure of the kidneys presents the same difficulty that is met with in that of other glandular organs: their arteries, veins, and excretories, are so infinitely minute, that the actual termination of the arteries and commencement of the veins and ducts is but little understood.

The *cortical* part forms the periphery of the kidney, and extends into its substance to the depth of two or three lines, sending septa or prolongations between the conical bundles of the tubular substance: its color is a brown red, and seems to be made up of the ultimate and tortuous ramifications of the arteries and veins. According to the microscopical observations of Dr. Eysenhardt, of Berlin, this structure is made up of minute granules, of oval and rounded forms; these by maceration become detached with their adherent vessels, and are rendered completely red by fine injection thrown in by the artery; they appear to be composed of minute plexus of vessels, surrounded by a grey colored substance, which is not granular. The veins could not be detected arising from them; this probably occurred from the veins being injected from the arteries, as I have myself injected the veins of the kidney in that manner.

The granules of the cortical part are held together by a minute net-work of greyish transparent vessels, which seem to be the commencement of the uriniferous tubes; this would throw doubt on the assertion, that each granule is furnished with its own excretory duct, running in a straight line to the tubular substance. Further than this the connection between the blood-vessels and glandular structure of the kidneys is little known.

The *tubular* substance appears to arise or be a continuation of the grey substance, which has been already described as connecting the granules of the cortical part; they unite into conical bundles, from twelve to eighteen in number; their bases are directed towards the circumference of the kidney, and their summits towards the pelvis and fissure. These cones are whiter in color than the cortical substance, particularly where they concentrate at their apices and form the mammillary processes. Each of these cones contains several tubuli uriniferi, which converge as they pass towards the mammillary process of the cone, uniting with each other, and finally opening by only two or three apertures into a calyx or infundibulum.

The *calices* or *infundibula*, form the second excretory portion of the internal structure of the kidney, and may be considered as the commencement of the ureter. It is formed of a dense fibrous tissue, surrounding the mammillary processes; and uniting with each other, form one common cavity around the pelvis, from whence the ureter takes its origin at the fissure of the kidney: but each mammillary process is not always furnished with a separate infundibulum, as sometimes two, or even three will open into one infundibulum. The fibrous tissue of the infundibula and pelvis is strengthened by the intimate connection of the proper fibrous tunic of the kidney.

The *function of the kidneys.*—The secretion of the urine appears to be wholly excrementitious, which is fully proved by an examination of the various constituents of the urine, under the different circumstances of health and disease. The principal excrementitious constituent of urine is in the form of the substance named urea or nephrin, and which is found in healthy urine, according to Berzelius, in the proportion of rather more than thirty parts in a thousand. The principal constituent of urea has been stated by Dr. Prout to consist of azote in the proportion of nearly one half;

hence the conclusion of Dr. Elliotson, that the kidneys are the great outlet for azote, as the lungs and liver are for carbon.

When the kidneys have been removed from animals, urine has been detected in the blood, and stated by Segalas in the proportion of one scruple to five ounces; he also found, that when an aqueous solution of urea was injected into the veins, it acted as a most powerful diuretic, so that in twenty-four hours it could no longer be detected in the blood. These facts seem to point out, that urea is not necessarily formed in the kidneys, as was formerly supposed, but that it is merely eliminated by these glands from the blood, which is furnished with this substance from all the other parts of the system. This must necessarily be the case, if the azote of the urea is furnished from the different textures of the body, during the process of their absorption, when being carried into the circulation, without some outlet the azote of their composition would form an injurious accumulation.

The urine is an extremely complex fluid, as may be seen from the following analysis of Berzelius, which presents the characters of healthy urine; but under different states of disease, its constituents will be infinitely varied, which renders the analysis extremely difficult.

Water	933·00
Urea	30·10
Sulphate of potassa	3·71
Sulphate of soda	3·16
Phosphate of soda	2·94
Muriate of soda	4·45
Phosphate of ammonia . . .	1·65
Muriate of ammonia	1·50
Free lactic acid	17·14
Lactate of ammonia	
Animal matter soluble in alcohol	
Urea not separable from the preceding	

Earthy phosphates, with a trace of fluate of lime	1·00
Uric acid	1·00
Mucus of the bladder	0·32
Silica	0·03
	1000·00

According to the analysis of Brande, the following constituents are always found in the urine:—

Water.	
Carbonic acid	Three free acids.
Phosphoric acid	
Uric acid	
Phosphate of lime	Two earthy phosphates.
Phosphate of magnesia	
Phosphate of ammonia	Two alkaline phosphates.
Phosphate of soda	
Muriate of soda	Chloride.
Albumen	Two animal compounds.
Urea	

and a trace of sulphate of soda.

Urea is soluble in water and in alcohol; it is precipitated by nitric and oxalic acid in crystals of a pearly hue; soda and potassa dissolve it.

Dr. Prout gives the following analysis of the ultimate elements of urea:—

Nitrogen	46·66
Carbon	19·99
Hydrogen	6·66
Oxygen	26·66
	99·97

These different substances found in the urine form a corroboration of the view taken of the excrementitious function of the kidneys, and which is rendered still more apparent from the alterations produced in its secretion by various diseases. Thus, in certain cases of rickets, the urine will be found saturated with phosphate of lime. When the functions of the liver are interrupted, the urine is often found loaded with bile, as is evident in jaundice, when the bile is generally diffused through the system. In typhus fever, gelatine and urea are abundantly contained in the urine. In intermittent fevers, the color of the urine varies with the paroxysm. Dr. Prout found a peculiar red deposit in urine after a fit of ague, containing an acid which, from its color, he has named rosacic acid. In gout, lithic acid is deposited in red crystals. In inflammatory fevers, the urine is red or dark colored at first; as the disease lessens it becomes turbid, and deposits a sediment of a reddish color, containing phosphate of lime, lithic acid, lithate of ammonia, and animal matter.

Uric acid appears to be peculiar to human urine, and to be formed by the union of urea with a small proportion of oxygen; it differs from urea in its strong tendency to crystalize upon any reduction of the natural temperature of the body: hence the ready formation of calculi in the human bladder, and the frequent turbid state of the urine. Quadrupeds, on the contrary, from the absence of uric acid in their urine, are rarely the subjects of urinary calculi; and those which do form are found to be composed of carbonate of lime, which being easily dissolved by the weak acids of the urine, do rarely concrete.

The secretion and course of urine take place from the ultimate distribution of the renal arteries, which have already been described as ramifying on the granules of the cortical substance of the kidney, from whence the commencement of the tubuli uriniferi have been traced; into these tubes the urine is poured, and is conveyed by them through the open mouths of the mammillary processes into the infundibula; from thence falling into the pelvis of the kidneys, it flows through the ureter into the bladder. Several opinions have been entertained respecting the force and mode by which the urine is propelled in this passage: some physiologists have considered that the ureters possess a muscular power; others attribute it to the general motion of the peristaltic action of the intestines, and contraction of the abdominal muscles; while others consider, these passages being always full of urine, each additional secretion must necessarily, from the incompressibility of fluid, displace an equal quantity from the opposite extremity of the tube into the bladder. This hypothesis is supported by the fact, that in experiments upon animals, and in cases of malformation of the anterior parietes of the abdomen, and anterior surface of the bladder, the urine is seen invariably flowing guttatim from the ureter.

The remarkable facility with which fluids find their way from the stomach to the bladder, has given rise to a supposition, that the absorbents have a direct communication between them, independent of the kidneys. Anatomy, however, does not verify these conjectures; although, occasionally, absorbent vessels much enlarged may be traced, but never, I believe, in distinct continuation.

One of the most remarkable phenomena attending the secretion of urine is, that certain substances taken into the stomach may be detected in the urine before they can be detected in the blood. Rhubarb, when taken into the stomach, was detected in the urine in seventeen minutes, by Sir Everard Home; and if doses are successively administered to animals for several hours before they are killed, not only the urine contains it, but it is also found in the splenic vein, vena cava inferior, and right auricle of the heart. Rhubarb may be detected in the bile, and in the urine, when it cannot be discovered in the lacteals. *(Vide* Exp: Sir Everard Home, Phil: Trans: Vol. CI. page 163.*)* The only way of accounting for this phenomenon is, that the blood possesses a power of preventing the usual operation of chemical tests: this fact was ascertained by Magendie; he injected prussiate of potash into the veins, and found that it might be detected in the urine, but not in the blood; and this power it also possessed when tried out of the body: chemical tests being unaffected when applied to solutions of prussiates of potash in the blood, while in the urine the slightest quantities were readily detected.

The average quantity of urine secreted in twenty-four hours is about four pints, but this varies greatly. In cold weather, when the skin is less active, its quantity is greatest; on the contrary, in warm weather, when there is an abundant perspiration, the quantity of urine is lessened, and its color heightened. It also varies considerably during the progress of febrile and other diseases; certain medicines, and particular kinds of food increase the secretion of the kidneys—hence the term diuretics. Several substances possess the power of impregnating the urine with particular odours; thus turpentine imparts to it the smell of violets, asparagus a peculiar fætor.

With regard to the facility of the secretion, and the quantity of urine formed, it may be observed, that the size of the renal arteries being in the proportion of an eighth of the calibre of the aorta, admits, by calculation, the passage of one thousand ounces of blood in an hour; and supposing that the blood contained only one tenth of the elements of urine, seven pounds and a quarter may be given out in this time,—which is more than is known to form, even under the influence of the most powerful diuretics.

The ureters descend from the kidneys along the lumbar regions, and pass over the margin of the pelvis to gain the inferior region of the bladder, into which they finally enter. Their mode of junction will be more particularly described when treating of the structure of the bladder, which is postponed until speaking of the organs of generation, their connection with the bladder being so intimate and important as to render their connected description essential.

The Organs of Generation.

The third class of organs contained within the cavity of the abdomen, are the organs of generation, which form the grand distinction between the male and the female, presenting an extensive variety of structure in the two sexes. We shall first speak of them in the male.

The organs of generation in the male, are composed of numerous parts, presenting a variety in their situation, and in the different functions they are destined to perform. They are therefore divided into the *external* and *internal.*

The external are, the scrotum enclosing the testicles, with a portion of the spermatic cord, and the penis.

The internal are, the remaining portion of the spermatic cord, the vesiculæ seminales, prostate gland, and commencement of the urethra.

The order which I shall adopt in the description of these various structures, is that which will be found most convenient to the anatomical student in the progress of his dissection, as well as that which is best adapted to the important surgical and physiological considerations of these parts.

The *scrotum,* is a pendulous sac or bag, composed of different structures, and divided into two cavities by a septum; each cavity containing one of the testicles. This pendulous bag is attached by its external or cuticular covering to the pubes, *above; laterally,* to the thighs; in *front,* to the penis; and *behind,* to the perineum; being free in the rest of its surface, and hanging down to a greater or less extent, depending on the age, vigor, and general state of health of the individual. It is particularly contracted by cold, and by a vigorous state of constitution; on the contrary, it is loose and elongated in states of debility.

The external covering of the scrotum, is a continuation from the common integument, its general organization being the same; it is however peculiar for its brown color, the quantity of sebaceous follicles which it contains, and the numerous hairs scattered over its surface in the adult. In its different states of contraction or elongation, it presents more or less of a rugous appearance, and it has a raphé in its centre, extending from its junction with the posterior part of the penis to the anterior part of the perineum; which raphé is a continuation of the mesian line of the body. The skin of the scrotum is extremely thin and transparent, and is connected to the subjacent parts by cellular membrane destitute of adeps.

The *dartos* is the covering next immediately under the skin, and has been supposed by many to possess a muscular structure, to which they have attributed the corrugation of the scrotum; by minute examination, however, no muscular fibres can be discovered, but it appears a pinkish cellular tissue, containing an extensive vascular distribution. It is connected, laterally, with the rami of the pubes, and ischia; and in the centre, with the raphé, from which it ascends to the urethra, and assists in forming the septum scroti.

The *superficial fascia* of the scrotum is the third covering, and lies immediately underneath the dartos; it is here so named, having been usually considered as a distinct covering; but it is, in fact, so inseparable from the dartos, that they appear to be one and the same. It is a continuation of the superficial fascia of the perineum, proceeding between the dartos and cremaster muscle, surrounds the testicles, assists in forming the septum scroti, and in retaining each testicle in its proper situation; it then passes upwards upon the outer side of the cremaster muscle, and, reaching the external abdominal ring, is continued with the superficial fascia of the abdomen.

The *cremaster muscle,* is the next layer of the scrotum usually described; it takes its rise within the inguinal canal, from the lower fibres of the internal abdominal oblique and transversalis muscles, and thence passes through the external ring, forming at once a covering to the spermatic cord and scrotum. As it passes through the external ring, it does not however lie immediately under the superficial fascia of the scrotum, for there is a thin layer of fibrous tissue proceeding from the edges of the external ring, which passes downwards along the cord, separating the cremaster from the superficial fascia, and may be termed the fascia spermatica externa.

The cremaster muscle is inserted into the tunica vaginalis reflexa, upon which its fibres are gradually lost, but are most abundant on the fore part of the tunica vaginalis. The cremaster is furnished with an artery of its own from the epigastric.

The true covering of the testicle, and which upon the descent of that organ becomes the fifth or inner layer of the scrotum, is the *tunica vaginalis.* This originally was a portion of the serous splanchnic membrane of the abdomen, and invested the testes in the earlier stages of fœtal growth; which having descended with the testes, now forms the tunicæ vaginales. At the earlier period of its descent, a communication remains between the serous cavity of this membrane and the peritoneum of the abdomen; but which soon closes by an adhesive inflammation separating the two cavities from each other. Precisely in the same manner as the peritoneum within the abdomen gives a covering to the viscera and parietes of that cavity, so do the tunicæ vaginales give a covering to the testes, and become reflected upon the scrotum. Hence these tunics present one external surface, closely attached to the organ (excepting only a small portion for the transmission of its vessels), and then is reflected on the internal surface of the scrotum; and another internal free surface, forming a closed serous cavity, smooth, and secreting a fluid similar to the other serous cavities, and facilitates the motions of the testicles. The portion of this tunic which covers the testicle, has been named the tunica vaginalis testis, while the reflected portion has been termed the tunica vaginalis reflexa or scroti.

The farther particulars of the prolongation of the tunicæ vaginales from the peritoneum, will be described when speaking of the descent of the testicle.

From the above description, it would appear that the tunica vaginalis lies immediately under the cremaster muscle, but this is not the case; for precisely in the same manner as the cremaster muscle is separated from the superficial fascia of the scrotum, by the fascia spermatica externa passing from the edge of the external ring; so is the tunica vaginalis separated from the cremaster by a fascia, which proceeds from the internal ring, and which may be properly named the fascia spermatica interna. Hence it is obvious, that the cremaster muscle is placed between these two fasciæ spermaticæ. *(Vide diagram I.)*

These fasciæ must, necessarily, form coverings in oblique inguinal herniæ, but it would perplex the student to enumerate them as distinct coverings; nor have they been so described by authors, probably in consequence of their extreme tenuity: nevertheless, under circumstances of disease, they may become so thickened as to form an important feature in the operation for strangulated hernia; and should, therefore, be perfectly understood by the surgeon.

The *scrotum* is supplied with blood by the external pudic artery, and the perineal branch of the internal pudic. The cremaster receives a branch from the epigastric.

The *veins* which return the blood from the scrotum, correspond in their course to the arteries; so that there is an external pudic vein conveying blood from the scrotum to the femoral vein, a perineal vein which terminates in the internal pudic, and a vein which opens into the epigastric.

The *nerves* of the scrotum are derived from the lumbar plexus by two branches, and also from the perineal nerve, which is a ramification from the internal pudic.

The *absorbents* terminate in the inguinal glands; hence these glands are affected in diseases of the scrotum, while the lumbar are affected in diseases of the testes.

Practical Remarks.

The diseases of the scrotum may be here properly mentioned, as in some of them there are peculiarities which are not to be met with in the skin of other parts of the body. The most peculiar of them is chimney-sweepers' cancer;—a disease which seems to be produced from the accumulation, and consequent irritation of the soot on the skin. It has been described by authors as a malignant disease; but I am disposed rather to consider it, in its earliest stages, as merely local; and its removal at this period usually eradicates the disease, and the patient is not liable to its return, unless he again subjects himself to the same irritating cause. On the contrary, when the disease is allowed to remain, and the surface of the wart or sore is constantly exposed to the soot, nature is foiled in her frequent attempts at reparation: the constitution becomes now affected; the sore assumes a malignant character, and the disease is propagated along the absorbents to the lumbar glands, and the patient is worn out by this additional source of irritation. Neither does it bear the character of the true malignant cancer in the period of life at which it occurs; for although, like cancer, it is not met with before puberty, yet, unlike cancer, it is not a disease of old age.

The first appearance of this disease is in the form of a warty tubercle, which secretes an ichorous discharge, producing a continued ulceration; which, if not removed and the irritating cause avoided, will go on to the destruction of life. The particular tendency of the scrotum to this disease, may be attributed to the numerous follicles it contains, and which necessarily is more prone to excitement from irritating causes.

Elephantiasis is a disease which also frequently attacks the scrotum, —probably connected with its follicular apparatus, and the quantity of cellular tissue found immediately under the skin. It occurs most frequently in warm climates, where it is indeed endemic; and has been frequently met with in Egypt, as described by Baron Larrey. It is comparatively a rare disease in cold climates. Tumours of this description sometimes acquire an amazing size, and present an irregular rugous surface, being sometimes deeply furrowed, and even ulcerated at the roots of the hairs; but the ulceration seems to be produced by the irritation of the urine flowing over its surface. If the tumour be cut into, it seems to be composed of a coagulated state of serum, accumulated in the cellular membrane, and containing very few blood-vessels; the surface of the tumour, on the contrary, is often highly vascular.

The amazingly large tumour weighing between sixty and seventy pounds, lately removed by my colleague Mr. Key, at Guy's Hospital, was, in my opinion, entirely of this kind.

Tumours of this description, in hot climates, frequently attack the pudenda in the female. I have in Guy's Hospital removed a tumour from this situation, weighing between four and five pounds, which had some of the characters of elephantiasis; but, however, differed in the greater solidity of its substance, and the size of the blood-vessels traversing its interior. It appeared rather to be a morbid growth of all the structures of the part, than a disease arising in any particular structure.

The mode of treatment which is to be recommended in the commencement of elephantiasis, consists of mercury, antimonials, acidulated drink, and all such medicines as are known to excite the action of the absorbent system. Friction, pressure, and mercury, will therefore be found useful as local applications; should these prove ineffectual, the removal of the tumour becomes necessary; in performing which, every care is to be taken to avoid the testicles and spermatic cords if they remain free from disease, which is usually the case, as they are protected by their enclosure in a serous membrane.

Of the Testes.

The testicles are invariably two in number, and are placed within the scrotum; their office is to secrete the semen. They are of an ovoid figure, about the size of a pigeon's egg, and are suspended diagonally within the scrotum, having the upper extremity of their long axis placed forwards, and the lower backwards. They present a superior and an inferior extremity, an anterior and a posterior edge, and two lateral surfaces.

The *superior extremity* is the larger, having the head of the epididymis overlapping it, and directed slightly outwards, so that the heads of the two epididymes diverge from each other; while the rest of the epididymes are turned inwards and backwards, in a direction towards each other: hence when removed from the body, suspending the testicle by the cord, one may be distinguished from the other by observing the direction of the epididymes. The axes of the testes are three, in the direction of their length, breadth, and thickness. The length in a fully developed testicle, measures from an inch and a half to two inches; the breadth, from an inch to an inch and a half; and the thickness, from nine lines to an inch. These proportions will be found to vary in different individuals. Each testicle weighs about an ounce. The *upper extremity* is larger than the *lower;* its *anterior edge* rounder than the *posterior;* its two *sides* are convex, but present a flattened appearance when compared to the greater convexity of the anterior edge.

Their secretion and excretion of the semen is effected by the conjoined action of several structures, which may be enumerated as follows.

The *body of the testicle*—composed of the tunica albuginea which forms its immediate envelope, giving the gland form and support exteriorly, and internally to its minuter structures, by sending off tendinous septa and membranous prolongations.

The *tubuli seminiferi*, are arranged in lobes and lobules between the septa and within the membranes of the tunica albuginea, taking their course from before to behind in the short axis of the tubuli.

The *rete*—a continuation of the seminal tubes, placed posterior to the tubuli, within a duplicature of the tunica albuginea, take their course from below upwards, in the direction of the long axis of the organ.

The *vasa efferentia*—a continuation of the rete from the body of the testicle to the epididymis.

The *epididymis*—placed behind the testicle, and is divided into head, body, and tail.

The continuation of the course of the semen beyond the epididymis, will be given with the spermatic cord, and the rest of the organs of generation.

The *tunica albuginea*, is a dense, white, tendinous tunic, resembling the dura mater; it is divisible into two layers,—the outer, fibrous, dense, and presenting the metallic lustre peculiar to this tissue in every other part of the body, possessing little vascularity; the inner layer is highly vascular, the spermatic artery ramifying abundantly on it before its minuter branches penetrate with the prolongations of this membrane to the lobular structure of the tubuli seminiferi, constituting the true parenchyma of the testicle. At the puper and posterior part of the testis, and a little to its outer side, the tunica albuginea splits into two layers; the outer and more tendinous layer is directed upwards along the cord, as well as surrounding the body of the testicle; the inner layer turns inwards and forwards towards the centre of the testicle, where it forms a septum, partly dividing the lobes of the body of the testicle into two sets, and which has been very aptly named by Sir Astley Cooper, the *mediastinum testis*.

From the anterior edge of the mediastinum, tendinous septa are given off, which traverse the substance of the gland, and are attached to the tunica albuginea on the fore part of the testicle. The septa divide the tubuli seminiferi into lobes, which lobes have a covering from the inner vascular membrane of the tunic, and which gives off minute membranes to subdivide the lobes into minute lobules, and finally sheathing the tubuli themselves.

The septa are for the purpose of supporting the sides of the testicle, and maintaining the proper position of the internal structure of the gland; and this object is further attained by other smaller ligamentous processes given off in various directions from the tunica albuginea, the mediastinum, and from the septa:—these may be termed the septula testis.

The septa and septula are not only for the purpose of strengthening the structure of the testicle, but they support the vascular membrane with its ultimate distribution of vessels.

The *tubuli seminiferi* form the principal part of the interior of the testicle, and present a pulpy substance of a greyish-red color, disposed in lobes of a pyramidal form; their bases being turned toward the lateral parts of the tunica albuginea, and their apices toward the mediastinum; being maintained in their situation by the vascular membrane enclosing them, and the septula supporting them. So minute are the tubuli contained within these lobuli, that, according to Munro's estimation, their calibre is not more than 1-200th part of an inch in diameter: they do not ramify, but are composed of innumerable convolutions; the total length of which, when unravelled, have been estimated at 5,200 feet. These tubes terminate in the apices of the pyramidal lobes at their junction with the mediastinum; and when they enter the substance of the mediastinum, are called the rete.

The *rete*.—In this situation the vessels of the rete take two directions: first passing parallel with the mediastinum, from before to behind, then turning upwards in the direction of the long axis of the testicle, they pass to terminate in the vasa efferentia. In the first direction they are enclosed within the mediastinum; but in their second, they are in that part which has been hitherto termed the corpus highmorianum.

The *vasa efferentia* are the continuations of the seminal canals from the upper and anterior extremities of the rete to the head of the epididymis, into which they terminate: they are from thirteen to fifteen in number; and it is stated by Sir Astley Cooper, that, from numerous dissections, he never found them more than fifteen; although Cloquet asserts that they sometimes amount to thirty. In consequence of disease they become obliterated, and have been found so few as six or seven in number: they arise separately from the rete, and terminate in the single tube of the epididymis. At first they present a single tube, which is but very slightly convoluted; but which, as it reaches the epididymis, is divided into numerous minute convolutions, each forming a conical mass or lobe, somewhat similar to the lobes of the tubuli seminiferi, but differ in this respect: that the bases of their cones are turned toward the epididymis, and their apices toward the rete. *(Vide diagram I. pl.* 2.*)*

The *epididymes*—so named from their covering the didymi or testes: they are rounded oblong bodies, attached to the posterior part of the testicles. They present a posterior rounded convex edge, an anterior thinner concave edge, a superior extremity or head which overlaps the testicle, a middle portion which is named its body, and a lower extremity which is called its tail or cauda. The epididymis is covered by the tunica vaginalis in the same manner as the testicle, which will be described when speaking of the descent of that organ from the abdomen. The vasa efferentia fill the epididymis, and are disposed in lobes, which are separated and supported by tendinous septa and septula, much in the same manner as the lobes of the tubuli within the body of the testes.

These lobes are so numerous at the upper part of the epididymis, that they here produce the enlargement termed the head, and which projects towards the outer surface of each testicle. In the body of the epididymis the lobes are more distinct, and may be readily unravelled; and, as it approaches the tail, the tube becomes larger in its calibre, and finally terminates in the vas deferens. Occasionally prolongations are found, from one to three inches in extent, passing from the body of the epididymis along the vas deferens, and terminating in blind pouches.

The seminal tubes having left the testicle form the vas deferens, when it immediately becomes situated at the posterior part of the spermatic cord, which being made up of other structures essentially connected with the testicle, should now be traced throughout its course.

The Spermatic Cord

Has already been referred to as suspending the testicle within the scrotum: it is made up of blood-vessels, nerves, absorbents, and the excretory duct, united by cellular membrane and covered by tunica vaginalis. It proceeds from the back part of the epididymis, rising above the testicle and enclosed within the layers of the scrotum, reaches the external abdominal ring; thence traversing the inguinal canal, and passing underneath the free edges of the internal oblique and transversalis muscles, gains the internal ring and abdominal cavity; where its character, as a cord, becomes lost by the separation of its constituent parts. The parts thus entering into the composition of the cord, and considered individually, are the spermatic artery, derived from the aorta; the spermatic vein, returning the blood not consumed in the secretion of semen into the general circulation; the nerves, derived from the sympathetic and lumbar plexus; the absorbents, passing to the lumbar and hypogastric glands; and the vas deferens, which, directly it has reached the abdominal cavity, separates itself from the cord, winds behind the epigastric artery, and descends along the side of the bladder, to reach the prostate gland. To trace the connection between the external and internal organs of generation, it becomes necessary to obtain a lateral view of the organs contained within the pelvis; but however, before this is done, it would be better to trace the progress of the testicle from the abdomen into the scrotum.

Descent of the Testicle.

The testes in the fœtus are placed in the same situation as the ovaria in the female: immediately below the kidneys, upon the fore part of the psoæ muscles. While in this situation, like all the other organs contained within the cavity of the abdomen, they are placed behind the peritoneum; receiving a close covering, excepting at their posterior part, where a space is left for the entrance of their vessels. But as this organ is destined to change its situation within the abdomen for one within the scrotum, we shall find a structure superadded, which is supposed to assist in the descent of the testicle, and which passes from the lower part of the body of the testicle and epididymis, behind the peritoneum, along the parietes of the abdomen into the scrotum, where it is spread out and lost. This structure has been named the *gubernaculum,* from the supposition that it guides the testicle into the scrotum; but, in the descent, nothing is apparent which indicates any forcible dragging down; on the contrary, in their whole descent, the vessels preserve their tortuous course. This process appears one of natural growth, and belonging to a particular period; for should any circumstance interrupt nature in her work at this period, she does not appear after, capable of exerting it, and the testicles remain within the abdomen during life. In the earlier periods of uterine gestation, the testicles are placed immediately below the kidneys, nearer to the origin of the spermatic artery than at any after period: the artery is even then, although so near its destination, found to take its peculiar tortuous course. Besides the gubernaculum, the cremaster muscle passes from the abdominal muscles, behind the peritoneum, to be inserted into the lower and back part of the testis and epididymis, and is also attached to the peritoneum. At the fifth or sixth month the testes are found upon the lower part of the psoæ muscles: the gubernaculum appearing to have become contracted or absorbed; while the cremaster muscle, by being drawn down, is formed into loops, which consequently surround the testicle in the manner of slings. This peculiar structure of the cremaster muscle has been first described, demonstrated, and beautifully delineated in the work on the testis, lately published by Sir Astley Cooper. About the eighth month or a shorter period before birth, the testicles descend into the scrotum: first having passed the internal ring, they are found in the inguinal canal, where they appear to receive a check to their progress, remaining in this situation for a greater or less period before they pass the external ring into the scrotum. While within the inguinal canal, the fibres and loops of the cremaster muscle form a complete bag or pouch surrounding them; and which bag, testicles, and the loose peritoneum of the anterior parietes of the abdomen, descend together into the scrotum. *(Vide diagrams, pl. 2.)* But it is to be remembered, that the testicle does not fall into a loose bag of peritoneum as a congenital hernia, but that it is placed behind the cavity formed by the pouch of the peritoneum, which is drawn down with the testicle, precisely in the same manner with respect to it, that it was, while within the cavity of the abdomen; excepting that the reflected portion of the peritoneum is much closer to that portion which is in contact with the testicle in the scrotum, than it was in the abdomen, from its having been drawn down, lengthened and narrowed in its descent. The peritoneum which is thus drawn down with the testes, is termed the tunica vaginalis: that part of it which is in contact with the testicle, is called the tunica vaginalis testis: while that in contact with the scrotum, is termed the tunica vaginalis reflexa or scroti:—a cavity being left between the two layers, in which a vapour is poured out, as in other serous cavities, to facilitate the motion of the parts. At first, after the testicle has descended, the bag of the tunica vaginalis and of the peritoneum communicate; but in a short time the neck of the vaginal bag, at the internal ring, sets up an adhesive inflammation, and the two cavities are shut out from each other. That this adhesive process commences at the internal ring, is proved by the water in the hydrocele of young children passing much higher up than in after life; for the adhesion of the pouch goes on gradually, till it obliterates the canal along the cord to the testicle. This obliteration does not, however, always take place; so that after the descent of the testicle, the vaginal and peritoneal bag may still communicate: in which case the patient is liable either to the escape of intestine, or to the formation of fluid between the two layers of the tunica vaginalis. The first disease is termed congenital hernia, and the second congenital hydrocele. They are both usually to be radically cured by the same treatment: namely, that the contents of the bag should be returned into the cavity of the peritoneum, and a truss be constantly worn, night and day, to promote the closing of the opening. It is safer, and should therefore be recommended, that the truss be worn to the age of puberty.

Sometimes the obliteration only partially takes place, closing the opening from the abdomen, but not extending along the tunica vaginalis of the cord: and again, it may happen that the obliteration will occur at the two rings only, leaving a cavity between them in the inguinal canal. An accumulation of fluid may take place in this situation, and is termed hydrocele of the cord.

There is some difficulty in forming a just diagnosis in these cases, the tumour being precisely in the situation of a bubonocele; but the absence of any functional derangement in the intestines, and the transparency of the swelling, are to be considered as the guiding marks. Should the transparency, however, not be perceptible, it is to be considered as highly rash to puncture the swelling; for as there are no urgent symptoms, the danger of opening an intestine should be avoided.

The testicles sometimes do not descend until the period even of twelve or fourteen years, or it may happen that only one has descended: in both instances there is a liability to the protrusion of intestine with the testicle. Nor is it of very rare occurrence that the testes should never leave the abdomen. John Hunter thought, that in such cases there was some imperfection in them; and that they had not therefore the power, or, as he termed it, the disposition to descend; not being actuated by the "stimulus of necessity." But this does not appear to be the case, as there are several instances recorded in which the testes, under such circumstances, were found fully developed. It involves, however, a curious physiological question, whether persons under these circumstances are or are not to be considered as sterile.

This completes the subject as connected with the testicle: and we shall now proceed, as proposed, with the anatomy of the side view of the pelvis.

Side View of the Pelvis.

The dissection of the side view of the pelvis is prosecuted by separating the left os innominatum from the sacrum, at the sacro iliac symphysis, and by cutting through the symphysis pubis, and continuing the incision through the perineum to the left of the urethra and rectum, so as to remove the extremity, leaving the genital organs and the contents of the pelvis in their relative position, connected with the right wall of that cavity.

Before entering into a consideration of the contents of the pelvis, it will be well for the student to reconsider the bony parietes of this cavity, and to bear in mind the changes of position of which it is capable in relation to the trunk and extremities, and the different directions which the axes of its outlets assume during these changes: a knowledge which alone can give confidence to the hand of the surgeon, when directed by the mind, unassisted by the eye.

The bladder should now be moderately inflated from the ureter, and the rectum distended with horse-hair, so as to preserve its cylindrical form without destroying its natural curve. The loose cellular membrane should be removed, so as to display the relative position of the viscera: which consist of the bladder with the terminations of the ureter, the prostate gland, the membranous portion of the urethra, the vas deferens, and the vesicula seminalis: these parts being bounded below and behind by the rectum.

The *bladder* is the organ which should now be described, as it belongs both to the second and third class of viscera contained within the abdomen. To the second class it performs a most important function, as a reservoir for the urine; and to the third class, namely, the generative organs, it is essential from its intimate connection with the prostate gland and vesiculæ seminales, as well as from its giving origin to the urethra.

The bladder is a musculo membranous bag or reservoir, capable of considerable distention and contraction, and destined to receive the urine. It is situated within the cavity of the pelvis under the usual circumstances of its distention, but may extend into the umbilical region from great accumulation of urine. It is bounded *above,* by the small intestines; *below,* by the prostate gland, vesiculæ seminales, vasa deferentia, and rectum; *before,* by the pubes; *behind,* by the rectum, and that portion of the small intestines contained within the *cul de sac* of peritoneum which passes from the posterior surface of the bladder to the middle anterior surface of the rectum. This *cul de sac* in the female is formed into two pouches by the uterus and vagina. Such is the usual description given of the boundaries of the bladder; but from its diagonal direction, both as it regards the viscus itself, and the position of the pelvis in relation to the spine, it results, that its upper boundary is formed partly of the posterior as well as the superior; and the anterior boundary, partly by the inferior: that is, by the perineum as well as by the pubes.

The form of the bladder varies remarkably at different ages and in the different sexes: in the adult male it is conical; in the adult female more capacious, particularly in the direction from side to side, giving it more of a globular than the conical form: in young children it approaches to a cylindrical form, probably from its being seldom distended by any great accumulation of urine.

The bladder in an empty state, from the pressure of the small intestines has its posterior surface pressed forwards upon the anterior, so as to produce a great diminution of its antero posterior axis, and to represent a flattened form. From this state the accumulation of urine produces distention in the following order:—at first the inferior and posterior part of the bladder begins to enlarge, in consequence of its meeting with less resistance in this direction, and from the gravitation of the urine itself: as the accumulation goes on, the bladder still increases in its axis from before to behind, its progressive increase being from below upwards; and when the upper part becomes distended, the bladder then assumes a globular form, at which stage it contains from eight to ten ounces of fluid, which commonly produces a desire for its expulsion. The further progress of distention will be found to be more particularly governed by the attachments of the peritoneum furnishing a firm resistance in every direction excepting at the superior parts, where the enlargement in extreme distention takes place, so that the bladder rises from the pelvis into the umbilical region, and will even form a conical body, projecting between the peritoneum and the inferior part of the parietes of the abdomen above the pubes.

As this subject involves so many points of interest, I have further explained it by an annexed diagram. *(Vide diagram I. pl.* 3.*)*

For this account of the progressive mode of the distention of the bladder, I am indebted to my friend the Baron Heurteloup.

The external surface of the bladder, from its numerous anatomical and surgical relations in which there are so many points of importance, has been necessarily subdivided into different regions, which should now be particularly examined.

The *superior region* or fundus, is that portion of the bladder which is constantly in contact with the small intestines, and which rises into the umbilical region under circumstances of extreme distention. Its summit is marked by the attachment of the urachus, which, at the same time that it divides this region into an anterior and a posterior portion, acts as the principal suspensory ligament to the bladder. Posterior to the urachus, the fundus is covered with peritoneum: anterior to it, the bladder is destitute of peritoneum; and it is in this space that it may be punctured when that operation is performed above the pubes. On either side of the urachus is also found an impervious cord, the remains of the umbilical artery; which also marks the division of the fundus into an anterior and a posterior half, as well as the boundary of the attachment of the peritoneum.

The *inferior region* is a triangular space, bounded in front by the prostate gland; behind, by the reflection of the peritoneum from the bladder to the rectum; and laterally, by the vasa deferentia and vesiculæ seminales. This space rests upon the rectum, with which it is connected by cellular membrane; and is of importance from its being the part punctured when the operation for the retention of urine is performed per anum; and also, from its being liable to be raised by enlargements of the third lobe of the prostate, producing retention of urine: to relieve which, the bladder should never be punctured per anum. In the female, this region of the bladder rests upon the vagina, and is anteriorly bounded by the meatus urinarius.

The *anterior region*, is that portion of the bladder which is connected with the pubes by the posterior layer of the deep fascia of the perineum, and by condensed cellular membrane and fat. Above, the fascia is termed the anterior ligament of the bladder, and extends from it over the prostate gland. This region is bounded above, by the anterior half of the fundus; below, by the prostate gland; and in front, by the pubes.

When the membranous portion of the urethra gives way within the pelvis, the course of the extravasated urine, or formations of matter, is directed between the bladder and rectum;

as the deep fascia of the perineum, and anterior ligament of the bladder, prevents its passage forwards to the perineum, or upwards behind the pubes.

The *posterior region* is entirely covered by peritoneum: it is bounded *above*, by the posterior portion of the fundus; *below*, by the inferior region; and is marked at the line of reflection of the peritoneum from the bladder to the rectum, or by a line drawn from the base of one vesicula seminalis across to the other. In the male it is separated from the rectum, more or less, by convolutions of the small intestines, and in the same manner in the female from the uterus.

The *lateral region* of the bladder may be designated as that portion of the viscus which receives the terminations of the ureters, and have the remains of the umbilical arteries and the vasa deferentia traversing their surfaces, anterior to the reflection of the peritoneum from the bladder to the rectum. These regions are necessarily bounded by the four others which we have already described, and are opposed to the levatores ani, and condensed cellular membrane at the sides of the pelvis.

The *neck* of the bladder constitutes that conical part which is surrounded by the prostate gland, and which is situated behind and below the arch of the pubes: it is more horizontal in its direction in the adult than in the period before puberty. In the female, this portion of the bladder, from the absence of the prostate gland, seems to be merely the conical termination of the organ before it ends in the meatus urinarius.

In the operation of lithotomy, if the section through the prostate gland be complete, the neck of the bladder is necessarily cut into.

The connection of the ureter with the kidney has already been described; but its course from that organ to the bladder was necessarily postponed until we had the opportunity of its demonstration in the side view of the pelvis.

The *ureters* are the excretory ducts to the kidneys, and are long membranous tubes about the size of a goose-quill: they commence from the pelvis of the kidneys, from which they are directed immediately downwards behind and below the renal vessels. They take their course downwards and inwards as far as the sacro iliac symphyses, where they turn into the cavity of the pelvis, to reach the lateral regions of the bladder to terminate in that viscus. The ureters, in their course, at first are placed upon the psoæ muscles as far as the sacro iliac symphyses; just above which, they cross the common iliac vessels; and as they gain the cavity of the pelvis, they pass over the internal iliac artery and vein, taking their course to the posterior part of the inferior region of the bladder, having behind them only fat and cellular membrane: but just before they terminate, in the male, the vasa deferentia pass around them, to reach the vesiculæ seminales. They are covered, while on the psoæ muscles, by the peritoneum; and as they are crossing the iliac vessels, the spermatic artery and vein pass in front of them.

The peculiar circumstances attending the opening of the ureters into the bladder, will be best seen and described when studying the organization of the bladder, and the parts are removed from the pelvis.

In the progress of the description of the side view of the pelvis in the male, we have next to describe the

Prostate Gland:

A part of great surgical importance, both in relation to operations and to its diseases.

Its form is that of a chesnut, or heart-shaped, being rounded at its posterior base, and more pointed anteriorly: its long axis is about an inch, and is placed nearly horizontally, but having a slight inclination forwards and downwards. It is bounded *above,* by the anterior region of the bladder, and its ligament; *below,* by the rectum; from which, however, it is separated by the posterior layer of the deep fascia of the perineum; *behind,* by the neck of the bladder, which it partly surrounds, with the termination of the vesiculæ seminales and vasa deferentia; *before,* by the membranous part of the urethra; and *laterally*, by the levatores ani.

The *vesiculæ seminales*, are two membranous bodies of an irregular conical form, about two inches in length, placed on the inferior region of the bladder, of which they form the lateral boundaries: they diverge posteriorly, and converge anteriorly, as they approach the prostate, in which they terminate. They are bounded *above*, by the bladder; *below*, by the rectum; *before*, by the prostate gland; *behind*, by the reflection of the peritoneum from the bladder to the rectum, and by the termination of the ureters; on the *inner* side, by the vasa deferentia; and on the *outer*, by the levatores ani. They are held in their situation by the fascia which passes from the posterior layer of the deep fascia of the perineum, continued to them from the prostate.

We have here also to notice the course of the vas deferens, which we have already described as far as its entrance into the cavity of the pelvis. (*Vide* page 115.)

From the internal ring it makes an acute angle, turning downwards and inwards, at the same time leaving the spermatic artery and vein. When within the inguinal canal, the vas deferens rested upon the fascia transversalis, and consequently anterior to the epigastric artery; but having passed the internal ring, it winds around that vessel, enclosing it in its angle, and is then situated on its inner side. The vas deferens, from this point, passes to the lateral regions of the bladder, continues in contact with that organ, passing downwards behind the termination of the ureter, between it and the bladder; from whence it proceeds along the inferior region to the inner side of the vesicula seminalis, with the duct of which it terminates in the prostatic portion of the urethra, in a manner which will be more particularly described with the organization of these parts.

To complete the description of these organs, it is necessary for the pupil to observe in the side view of the pelvis, the relative situation of the rectum, which, instead of being straight in its course, as its name implies, forms a complete curve; the first third of its length passing from the anus to the os coccygis, is straight, lying beneath the posterior half of the membranous portion of the urethra, the prostate gland, the neck of the bladder, vesiculæ seminales, and termination of the vasa deferentia: the middle third lies in the lower portion of the hollow of the sacrum, and is curved, presenting its convexity backwards and upwards, and its concavity forwards towards the bladder: the superior third, which commences at about the second bone of the sacrum, passes upwards with a slight obliquity forwards, obeying the bend of the sacrum, to reach the lumbo-sacral articulation, where it terminates in the sigmoid flexure of the colon.

Having described the relative position of the contents of the pelvis, the student should now take an articulated pelvis, and place it in a corresponding position to that of the subject; and which position should be precisely that adopted in the performance of operations on the urinary organs.

In the erect posture of the body the axis of the pelvis, in its upper and anterior outlet, forms an acute angle with the perpendicular line of the spine; while the axis of the lower or posterior outlet, forms a very obtuse angle with the same perpendicular line. *(Vide diagram I. pl. 4.)*

In a full sized male pelvis now before me, the following points appear to be most worthy of remark, in relation to the operations on this part of the body. The highest points of the crista of the ilia rise above the sacrum to a level with the middle of the body of the fourth lumbar vertebra: a line drawn from the anterior and superior spinous process of the one ilium to the other, is on a horizontal plane with the junction of the last lumbar vertebra with the sacrum, at a distance of two inches and a quarter anterior to it; while it is, on a perpendicular plane, four inches above the symphysis pubis. The distance across the cavity of the pelvis, from the superior part of the symphysis pubis to the junction of the sacrum with the os coccygis, is five inches and a half; while the distance from the arch of the pubis to the same point, is four inches and six eights: these two admeasurements shew the obliquity of the symphysis pubis, in relation to the cavity of the pelvis; and which obliquity is one cause of the diminution of the lower in proportion to the upper outlet. From the arch of the pubes to the point of the os coccygis, is three inches and six eights; while from the symphysis pubis to the same point measure five inches, and is very nearly on a horizontal plane. It may be worthy of remark, that in the direction of a line drawn from the arch of the pubes to the extremity of the os coccygis, the lower opening of the pelvis is principally enlarged during parturition.

These points having been observed in the erect position of the skeleton, we shall now apply them to the pelvis, and the viscera it contains, in reference to surgical operations.

The position should be such that the axis of the pelvis, instead of forming an acute angle with the perpendicular line of the spine as in the erect posture, should be brought parallel to it or nearly so; as is the case when the pelvis is slightly raised and the thighs flexed, in the recumbent position of the body. *(Vide diagram II. pl. 4.)*

When the subject is thus placed, the lower opening of the pelvis is immediately presented to view; and from the changed direction of its axis, in relation to the spine, the surgeon gains the advantage of the whole circumference of the lower outlet. It is in this position that the following admeasurements of the inferior outlet of the pelvis should be particularly borne in mind. In the recent subject, the tuberosities of the ischia present the most prominent points of the lateral boundaries, and are distant from each other from three and a half to four and a half inches; while the perpendicular axis, constituting, in the recent subject, the space occupied by the perineum and anus; and, in the skeleton, between the arch of the pubes and extremity of the os coccygis, are, in this position, nearly in a perpendicular line, and on a plane two inches posterior to the line drawn from the one tuberosity of the ischium to the other. In the posture in which we are now considering the pelvis and recent subject, the line from one tuberosity to the other divides the lower outlet of the pelvis into an upper and a lower portion; which, in the erect posture, are anterior and posterior. The upper portion constitutes the perineum, and is connected with the genital and urinary organs: the lower contains the anus, and is connected with the process of defecation. The perineum is seperated from the cavity of the pelvis by its deep fascia; leaving, however, an opening for the passage of the urethra, immediately under the arch of the pubes; and below, forming a crescentic edge over the superior surface of the rectum.

If the upper portion of the outlet be divided by a perpendicular line drawn from the arch of the pubes to the imaginary line already spoken of,—from one tuberosity to the other,—the precise direction of the raphé of the perineum is pointed out, which may be considered by the surgeon as his director through all the intricacies connected with the operations of those parts: leading him into the urethra either anterior to the bulb, into the bulb itself, or into the membranous portion of the urethra. *(Vide diagram III. pl. 4.)*

Before we remove the bladder and organs of generation from the cavity of the pelvis, in order to study their organization, it will be necessary to observe the attachments of the penis, and course of the urethra from the penis to the bladder.

The *penis* is one of the external organs of generation, and is attached to the symphysis pubis by the suspensory ligament, and to the rami of the ischia by its crura. Between the two diverging crura of the penis, the bulb of the urethra is placed; from the posterior part of which, the membranous portion passes through an opening in the deep fascia of the perineum to the prostate gland, which surrounds it.

The side view of the perineum being exposed as well as the side view of the pelvis, their connection, maintained by the passage of the urethra under the arch of the pubes, should be carefully observed; and also the situation of the muscles of the perineum, which have been particularly described. (*Vide* Vol. II. p. 173.)

The urinary and genital organs connected with the pelvis should now be removed, in order to examine their minute organization; in doing which, the bladder should be detached, the ureters and vasa deferentia cut through, leaving the bladder connected with the penis, which must be carefully dissected from its attachments; at the same time, examining the crura and suspensory ligament.

The Organization of the Bladder.

Its relative position, and its regions, being already described, we have now only to speak of its organization.

The bladder is composed of three coats, one of which is however only partial: these coats are the serous, the muscular, and the mucous.

The *serous* coat only partially covers the bladder, in a manner that has been described when speaking of the reflection of the peritoneum, of which this covering is formed. It passes from the anterior parietes of the abdomen to be reflected upon the upper posterior, and the posterior portions of the lateral regions; leaving the anterior, anterior portions of the lateral, and the whole of the inferior regions of the bladder uncovered. It is attached to the second, or muscular coat, by cellular membrane of rather a loose texture, which surrounds the remaining portion of the viscus, constituting, by the description of some anatomists, a distinct coat, and proceeding principally from the ligaments of the bladder.

The *muscular* coat is, both in color and thickness, very similar to the muscular coats of the stomach and intestines; disposed in various directions, so that their united contractions may tend to diminish the capacity of the organ in every direction, and equally press upon its contents. The greater number of these fibres pass in a longitudinal direction: they are thickest and most numerous at the neck of the bladder, and comparatively but a few appear to pass in a transverse direction. Several fibres may be seen in the mesian line of the bladder, passing from the prostate gland and neck towards the urachus: the remainder from the lateral parts of the neck, ascend to the superior region, where they meet, and even cross each other, before they are gradually lost. The thickened portion of these fibres, which constitute as it were the muscular paries of the neck, has by some anatomists been described as the sphincter vesicæ. The muscular is connected with the third, or mucous coat, by a whitish, dense tissue of cellular membrane.

The *mucous* coat of the bladder is continuous with the membrane lining the ureters and urethra. It is thin, whitish and delicate, covering the interior of the organ; and in the collapsed or empty state of the bladder, assumes innumerable minute wrinkles or rugæ. This membrane is lubricated by mucus, to defend the organ from the irritation of the urine. The villi and follicular apparatus are very minute, and are scarcely distinguishable, excepting in certain cases of disease, when they are rendered manifest.

There are three openings into the bladder, placed at its inferior region, one anteriorly and two posteriorly, describing between them a triangular space, which has been termed by Lieutard, *la trigone de la vesie*, and which space corresponds to the external surface of the inferior region of the bladder: here the mucous membrane has little or no rugæ, and its sides are marked by two thickened projections, which are caused by corresponding enlarged muscular fibres passing from the termination of the ureters towards the neck of the bladder; these have been considered by some anatomists to be for the purpose of regulating the flow of urine into the bladder.

The terminations of the ureters into the bladder form somewhat of an oval opening, which is prolonged between the mucous and muscular coats for the space of an inch, which construction answers the purpose of a valve to the ureters; for as the bladder becomes distended, this canal is compressed, the mucous membrane being fixed against the muscular coat.

The *arteries* of the bladder arise from the branches of the internal iliac; they take a tortuous course, and are most numerous towards the inferior portions of the lateral regions.

The *veins* are more numerous than the arteries, and form a very considerable plexus, which is termed the hypogastric; and from which veins pass to terminate in the venous trunks, corresponding to the course of the arteries.

Its *nerves* are derived from two sources, the hypogastric, and lumbo-sacral plexus; the former furnishing it with its involuntary, the latter with its voluntary powers.

Its *absorbents* terminate in the hypogastric ganglia.

The organization of the prostate gland.—This gland has no proper capsule, but is held together by a dense cellular membrane, giving it great firmness; it is attached *above*, to the anterior ligament of the bladder, which invests its upper surface; *below*, it is covered by the posterior layer of the deep fascia of the perineum, which connects it with the upper surface of the rectum. When cut into, its color is a yellowish grey, and appears to be made up of a mass of numerous follicles, which secrete a viscid fluid of a whitish color. The excretory ducts of these follicles are about fifteen in number; they are directed obliquely forwards, and terminate within the prostatic portion of the urethra, by the sides of a projection termed the *veru-montanum* or *caput gallinaginis*. On compression, the secreted fluid of this gland may be seen to exude from the orifices of its ducts.

We have already observed, that the general figure of the prostate gland is that of a chesnut, or heart-shaped; it is divided by a longitudinal fissure into two lateral lobes,—this fissure being much more defined on the inferior than on the superior surface: at the posterior part or base of the inferior surface, a small process connects the two lateral lobes; this is described as the third lobe of the prostate, and is remarkable for its enlargement in advanced periods, frequently increasing to the size of the rest of the gland; pressing, in such instances, the inferior region and trigone of the bladder upwards, so as to form an impediment to the passage of the urine into the urethra. The urethra traverses the prostate from behind to before; but not immediately through the centre of the gland, but nearer to its upper than to its lower surface. The terminations of the ducts of the vesiculæ seminales and vasa deferentia, enter at the posterior portion or base of the prostate, traversing its substance in a canal, which is directed forwards, terminating in the urethra. Whether the secretion from the prostate gland be necessary to generation, or whether it be merely to lubricate the surface of the urethra, is a physiological subject not well understood.

Organization of the vesiculæ seminales.—They are covered by a dense external coat, similar in structure to the exterior of the vas deferens, but somewhat thinner and more transparent; their inner coat is nearly white, very thin, and is a continuation of the genito-urinary mucous membrane, and has been compared in this situation, to the inner coat of the gall-bladder.

The vesiculæ seminales are made up of several conical or pyriform cavities; these join together, forming a neck or elongated extremity, which passes forwards to be united with the vas deferens, with which they terminate as a common duct. When the vesiculæ are cut open, they present an appearance as if made up of numerous cavities; but this appearance is the result of various sections being made of a single convoluted tube; as is proved by the possibility of their being unravelled in the same manner as the epididymis. The secretion of the vesiculæ seminales is a yellowish opaque fluid, having a peculiar smell, and of a browner color than the semen. They were considered formerly as merely reservoirs for the semen; but John Hunter found that they were filled with the same fluid in persons whose testicles had been removed: he conjectured, therefore, that this fluid served the purpose of a vehicle in the passage of the semen. Such conjectures, with many others that have been entertained upon this subject, serve only to prove that the function of the vesiculæ seminales is not understood. Certain animals are without these organs, as in the carnivora and ruminantia.

Cowper's glands—are two ovoid glandular bodies, situated at the back part of the bulb, and on the sides of the membranous portion of the urethra. They are of a pinkish color, and about the size of peas. Their surface is rather uneven, similar to a conglomerate gland; and they have been compared to the salivary glands. The excretory duct of each is about an inch in length, and passes obliquely forwards to terminate in the urethra, anterior to the membranous portion. They secrete a fluid which is discharged with the semen, but the use of which is wholly unknown. They are often wanting.

A small gland of the same nature has been mentioned by Cloquet to have been met with in the angle formed by the union of the roots of the corpora cavernosa. Like the vesiculæ seminales, in some animals they are found of large size, or numerous; while, in others, they are altogether wanting. But carnivora and ruminantia, which are deficient of the vesiculæ seminales, are furnished with Cowper's glands.

Of the Penis.

The *penis* has a double office to perform, being destined to convey the semen for the purpose of propagation, to the female, as well as to act as an excretory organ to the bladder. For the first object, a peculiar state of the organ is essential to the act; and we shall find, therefore, a structure capable of being distended under such excitements only as lead to the desire for the other sex: while, on the contrary, to perform the duties of an excretory canal to the urinary bladder, it may be considered completely as passive, the muscles of the bladder and abdomen being the active organs in micturition.

The penis is of a cylindrical form, is attached by what is termed its root to the pubes; its free or anterior extremity is formed by the glans and prepuce, and the intermediate space is termed the body. In the ordinary state, it is pendulous in front of the scrotum.

Organization of the penis.—It is composed of *integument,* which forms a general envelope; of the *corpora cavernosa,* which form the upper part and sides of the body; of the *corpus spongiosum,* which is placed inferiorly, and terminates in the *glans;* and of the *urethra,* which passes through the whole length of the organ.

The *integument* of the penis is continued from the scrotum and pubes; it is very thin, darker colored than the integuments of the other parts of the body; towards the root is furnished with numerous sebaceous follicles, and with a few hairs, which are directed forwards. At the under part of the penis there is a projection in the skin, termed the raphé, which is continuous with that of the scrotum. The integuments project beyond the free extremity of the penis, terminating in an opening which prolongs itself over the glans, and forms what is termed the *prepuce*; it is attached to the under part of the glans by a fold or puckering of the skin, called the frænum, and which is continued nearly to the opening of the urethra.

The prepuce is composed of an external cutaneous and of an internal mucous layer, connected with each other by an intervening cellular tissue. The internal mucous lining, commences from the anterior extremity of the prepuce, around its aperture, proceeds backwards to the corona glandis, is reflected over the glans, and terminates at the opening of the urethra, by becoming continuous with it: where it is reflected from the prepuce to the corona glandis, it forms a *cul de sac;* which, on the three upper fourths, is applied against the corpora cavernosa; but its inferior fourth is lengthened to form the frænum, and proceeds along the glans as far as the urethra. Immediately behind the corona glandis, and beneath the prepuce, are situated a number of small sebaceous glands in rows, which are termed the glandulæ odoriferæ or Tysoni: they are about the size of a mustard seed, and secrete a thick unctious humour of a very fœtid smell, which lubricates the surfaces of the glans and prepuce. Beneath the skin of the penis is a superficial fascia, which is continued above, from the superficial fascia of the abdomen; and below, from the dartos of the scrotum: it extends around the penis as far as the corona glandis; it is sufficiently loose to allow of the free motion of the skin of the organ. Anteriorly and at the upper part of the root, this fascia is thicker than at the other parts, and forms a kind of superficial suspensory ligament.

The *corpora cavernosa* constitute the principal part of the penis, forming two-thirds of the bulk of the organ, and is the part which, by its distention, produces erection. They are two cylindrical bodies, closely applied to each other, extending from the rami of the ischia and pubes, to the glans penis.

The commencement of the corpora cavernosa are termed the crura, and are attached to the whole length of the rami of the ischia and pubes; in the course of which attachment the two cylindrical bodies are separated, but converge as they approach the arch of the pubes, immediately beneath which they unite to form one body; and in the under part of the angle, formed by their union, the bulb of the urethra is placed. At the upper part of the union of the crura of the corpora cavernosa, the *ligamentum suspensorium* is attached, which connects them with the symphysis pubis: it is of a triangular figure, arising from the symphysis, and is inserted into each crus: it consists of two laminæ, between which the dorsal vein and nerves of the penis pass. The corpora cavernosa, in the body of the penis, are united by a septum, called the pecten; which commences at the symphysis pubis, but does not reach so far as the glans; a little before which they again separate, terminating in two rounded extremities, which are capped by the glans penis. This septum does not form a complete separation, being made up of parallel and vertical fibres; between which are openings, allowing, under certain circumstances, the transmission of fluids from one corpus to the other.

The union of the corpora cavernosa is further marked by a superficial groove on the upper part or dorsum, which lodges the dorsal vessels and nerves; and by a deeper groove inferiorly, which partly surrounds the corpus spongiosum and urethra. The corpora cavernosa are covered by an elastic fibrous sheath, composed of fibres which pass principally in a longitudinal direction, and are continued from the periosteum of the ossa ischia, and from the tendinous insertions of the erectores penis muscles: it is not of the same density throughout; being attenuated and more transparent in the groove which receives the corpus spongiosum, and the extremities which contain the glans.

The substance of the corpora cavernosa is made up of a spongy tissue, which fills this fibrous membrane. Considerable difference of opinion exists with regard to the ultimate structure of this substance; but it appears to be a multitude of cells, composed of a complicated lace-work of arterial and venous vessels, with filaments of nerves, supported by minute fibrous laminæ, continued from the exterior fibrous tunic, and which does not very much differ in structure from the tunica albuginia of the testicle; being also for the purpose of giving support and strength to the interior organization. The cells of each corpus cavernosum freely communicate: an injection thrown into the artery readily fills both veins and cells: whence it has been conjectured that these cells are intermediate between the arteries and veins. This is not, however, satisfactorily proved; for it is still considered by some physiologists, that these cells may be formed by a peculiar tortuous arrangement of the vessels themselves.

Corpus spongiosum urethræ, is a cylindrical body, enclosing the urethra, and situated below and between the corpora cavernosa; it does not, however, enclose the whole length of the urethra, the posterior fourth of that canal being placed behind and below it. This spongy body commences by a large conical projection, placed between the crura of the corpora cavernosa, and behind their union; it is called the *bulb*, and extends from the root of the penis to near the anus. This portion of the corpus spongiosum first receives the anterior extremity of the membranous portion of the urethra, the sides of which it overlaps, and has placed between it and the urethra, on either side, Cowper's glands. It then becomes contracted, and extends as far as the anterior extremities of the corpora cavernosa, as a uniform cylindrical sheath, where it expands itself into a large conical formed body, which is termed the glans penis.

The *glans* has the form of a truncated cone, presenting a base posteriorly, which overlaps the corpora cavernosa, and is separated from them by a furrow, which may be termed the cervix, and in which the glandulæ odoriferæ are placed. A prominent edge or margin terminates the glans posteriorly, forming what is designated the corona glandis. The superior surface of the glans is nearly twice as long as the inferior, which forms a projection before mentioned, under the name of the frænum preputii. The apex of the glans forms a pointed termination, which is pierced by the urethra. The corpus spongiosum is covered by a fibrous tissue, in a similar manner to the corpora cavernosa: in its internal structure it seems to be composed of a minute interlacement of capillary vessels, either connected by, or ramifying on a delicate cellular tissue, but capable of receiving a considerable quantity of blood, so as to produce its general distention: hence it has been termed an erectile tissue.

The *urethra* is the excretory canal, both for the urine as well as for the semen, extending from the neck of the bladder to the apex of the glans penis. In taking this course it does not pass in a straight direction, but forms incurvations, the situations of which it is essential for the surgeon to perfectly comprehend. The urethra, when it first leaves the bladder, is directed slightly downwards, to enter the prostate gland, gaining here the name of the *prostatic portion*, which is from an inch to an inch and a half in length, running through the substance of the gland somewhat obliquely, and firmly connected to its sides. The urethra, immediately it has left the prostate, becomes contracted, and passes through the deep fascia of the perineum, under the arch of the pubes, to the bulb; being in this extent termed the *membranous portion* of the urethra: it is about an inch in length. This portion of the urethra has a posterior internal and an anterior external half: the posterior is situated within the cavity of the pelvis, and is bounded *behind*, by the prostate gland; *before*, by the opening through the fascia; *above*, by the arch of the pubes and anterior ligament of the bladder; *below*, by the rectum; and *laterally*, by those portions of the levater ani muscle which have been termed Wilson's muscles. The anterior half is placed between the deep fascia of the perineum and the bulb which nearly surrounds it, and is therefore situated within the perineum: it is the portion of the urethra which should be cut into in the operation for the stone, or in the operation per perineum for retention of urine. The membranous part of the urethra, in its course from the prostate to the bulb, forms a curve, the convexity of which is turned upwards towards the pubes: it is this curve which frequently renders the passage of an instrument along the urethra into the bladder difficult, but which may be obviated by the surgeon raising the penis to an angle of 45°, at the same time drawing it forward; and, in case of more than usual difficulty, by the finger being introduced into the rectum, so that the point of the instrument may be directed into the bladder.

As soon as the urethra enters the bulb, which forms its third portion, frequently termed the *spongy*, the canal enlarges; but principally in the under part of its circumference, so as to form a kind of sinus here, and is supposed to act as a reservoir for the semen and urine, to be acted upon by the accelerator muscles which immediately surround this part. It is this sinus also which renders the necessity, in passing a catheter, of raising the point of the instrument at this part, to ensure the sweep of it into the bladder. From the bulb the urethra continues, for about seven inches in length, to terminate at the apex of the glans.

The urethra should now be cut open to examine the interior of the canal, particularly the enlargements and contractions which it naturally presents. Its *first* enlargement is in the prostate gland; its *second* enlargement is within the bulb forming the sinus Morgagni; and the *third* is within the glans, which is termed the fossa navicularis. Its *first* contraction commences at the membranous portion of the urethra, and continues until it enters the bulb; the *next* contraction is when the urethra enters the glans; and the *third* is at the orifice of the urethra, and which is sometimes so contracted as to require enlargement before an instrument can be introduced; which, when once beyond this obstruction, readily passes into the bladder. *(Vide diagram, pl. 5.)*

Organization of the urethra.—The urethra is formed of a mucous membrane, connected with the surrounding spongy body by a dense cellular tissue: it is continuous with the mucous membrane which covers the glans penis and prepuce, anteriorly; and with the lining membrane of the bladder, and excretory ducts, posteriorly. The urethra is of a pale white color, excepting at its orifice, where it is a vivid red. It is furnished with numerous lacunæ, which are directed obliquely from behind to before, presenting their openings towards the orifice of the urethra: one large one, called the lacuna magna, is placed within the glans and upon the upper surface of the urethra. From each of these lacunæ a projecting column extends, from before backwards; and there is a tendency to the formation of a middle raphé, towards which the columns converge. This raphé is particularly apparent in a line extending from the lacunæ magna along the upper surface of the canal.

At the under part of the urethra, just at the commencement of the membranous portion, is a prominent oblong body, termed the caput gallinaginis or veru montanum; from which extends a projecting elevation through the whole of the membranous portion, and more or less marking the inferior surface of the urethra with a raphé, similar to that just noticed in the upper surface. On either side of the veru montanum, the common duct of the vesiculæ seminales and vasa deferentia enter. On the upper surface of the projection is often an opening, or blind pouch: hence called *foramen ræcum* or *sinus pocularis*, from its having been compared to a cup. It has been supposed to be formed for the purpose of protecting the seminal ducts from the entrance of the urine; which, in flowing through the urethra, presses upon the orifice of their ducts. It does not always exist, and is considered by some to be merely a large lacuna.

On each side of the veru montanum is a smooth surface, on which the ducts from the prostate gland open, pouring out their secretion, which, with the semen, is directed on either side of the elevated ridge, extending along the membranous portion of the urethra to the enlarged cavity in the bulb.

It is by many considered that the urethra possesses muscular power; and that muscular fibres are to be met with, passing in a longitudinal direction, very short in their course, interlaced and united at their origin and extremities, and lying between the inner membrane of the urethra and the corpus spongiosum, and being most abundant towards the glans. That the urethra possesses a power of contraction, independent of any disease, is evident from the occasional grasping it exerts in the passage of a bougie; but I should rather attribute it to a power resident in the membrane, than to the contraction of muscular fibres.

As I have before mentioned the double office of the penis, both in procreation and micturition, it is necessary now to mention the circumstances attendant on erection; for this purpose we must describe the course of the circulation of the blood in the penis.

The *arteries* are derived from the internal pudic, which sends off four distinct branches to this organ: one to each corpus cavernosum, and two to the bulb to ramify in the corpus spongiosum.

In the corpora cavernosa it is supposed that the arteries pour their blood into the cells of the part, from which cells the *veins* arise; while in the corpus spongiosum and glans, the arteries are believed to terminate in the veins, which form a plexus of convoluted vessels, frequently uniting, and producing, therefore, a retardation of the flow of blood. The blood is returned from the penis by large dorsal veins, which usually at the root form one large vein, termed the vena magna ipsius penis, which finally empties itself in the internal iliac vein. From this peculiar course of circulation we may observe, that the blood brought by four arteries, and returned only by one vein, must necessarily distend the organ; particularly when the arteries are excited to inordinate action by the powerful stimulus of the mind. It has been supposed, that the erection of the penis is further maintained by the pressure of the vena magna against the arch of the pubes; but if this mechanical pressure were the cause, how could the penis regain its flaccid state, since the blood has no other outlet? It is therefore rather to be attributed to the cessation of the stimulus of the mind.

The *nerves* of the penis are derived from the lumbo-sacral plexus; the *absorbents* of the penis take a superficial and deep course: the former terminate in the inguinal, and the latter in the hypogastric glands.

This finishes the account of the situation and structure of the organs contained within the cavity of the abdomen; and it must necessarily be observed, that these three classes, namely, the organs of digestion, the organs for the secretion and excretion of urine, as well as those of generation, are all more or less connected with the cavity of the pelvis: hence, therefore, arises the propriety of dwelling yet upon the precise relative situation these several organs maintain, with respect to each other, in the construction of this cavity and its contents.

Before quitting the subject of the pelvic viscera, it will be proper to notice those organs and structures so frequently involved in such diseases as fall more immediatly under the consideration of the surgeon. We know that from various causes,—and from none perhaps more frequently than from indigestion,—that the urine, that complicated secretion, frequently deviates more or less from its natural composition, so as to undergo changes, giving rise to the most urgent symptons. These changes may consist of various substances, eliminated by the kidneys from the circulation, and passed off with the urine in solution; or they may consist of new combinations of the substances eliminated; giving rise to various calculous formations, which are met with in the calices and pelvis of the kidney, in the ureter, in the bladder, and in the urethra.

Calculi in the kidney.—In this situation they give rise to symptoms of nephritis, and not unfrequently lead to extensive abscesses, and sometimes to the complete destruction of the organ. These complaints are indicated by pain, usually of a lancinating, but occasionally of a dull character, in the region of the loins: which is increased by some, and diminished by other positions of the body; sometimes coming on suddenly, and as suddenly leaving; at others, extending down the course of the ureter to the bladder, or even to the groin and thigh of the side affected; together with numbness of the thigh, and retraction of the testicle. The patient is often affected, especially during the continuance of the pain, with irritability and sickness of the stomach; and rigors are not unfrequently felt when the disease has proceeded to suppuration, indicated by the pain becoming of a dull, heavy and throbbing character, and by pus mixed with the urine, which becomes scanty in quantity. In such cases the surgeon will rarely be called upon to interfere by operation; there are, however, exceptions to this: as for instance, when the pus, instead of finding a free exit with the urine, occasions ulceration, which tends towards the surface, and requires to be evacuated. It frequently happens, in long protracted cases of calculi in the kidneys producing suppression of the secretion of urine, that the patient dies from serous apoplexy.

Calculi in the ureter.—Is indicated by the seat of the pain in the course of the ureter, and its occurring more particularly in sudden and violent spasms; there is frequently, however, great obscurity in detecting the stone in the ureter, in consequence of the symptoms accompanying it, being precisely similar to those of stone in the kidney: such as pain and irritation in the course of the canal, pain in the loins, numbness of the thigh, retraction of the testicle, pain in the groin, nausea, vomiting, and suppression of urine. One of the clearest diagnostic marks is, the shifting of the pain as the calculus changes its position in its progress along the ureter. It does, however, sometimes happen, that calculi pass along the whole length of the ureter into the bladder, without having occasioned a symptom from which their presence could have been suspected. Cases are on record of calculi having become fixed near the termination of the ureter, when they have been felt by examination per anum; and Le Dran mentions a case in which a calculus partly protruded into the bladder from the ureter, where it was so firmly fixed, that he was prevented from removing it by operation; but by a second operation he succeeded in its extraction, from the parts which enclosed it being ulcerated.

Calculi in the bladder.—It is when calculi lodge within the bladder, that the case becomes one of the greatest surgical importance. In this situation they may either be first formed from the precipitation of earthy matters contained in the urine; or they may enter from the ureter, and become a nucleus for further depositions. There are other causes occasionally furnishing nuclei to the deposition of calculous matter; such as the accidental presence of foreign bodies, a small coagulum of blood, or any tenaceous or albuminous matter, at first collecting a loose aggregation of earthy particles, which subsequently may form a more compact and solid mass. From each of these circumstances symptoms, sooner or later, occur of the most distressing kind, and which can alone be removed by the performance of a formidable operation. The stone, while yet very small, produces generally but little irritation, but now and then it has a tendency to obstruct the free passage of the urine, by its being forced against the orifice of the urethra; hence an irregular flow of urine is one of the earliest symptoms: at the same time, upon the expulsion of the last portions of the urine, the contraction of the bladder directs the calculus towards the neck of the organ, and gives rise to the sympathetic pain so commonly felt at the extremity of the penis. Occasionally, small calculi will either pass through the urethra without occasioning inconvenience, or they may be lodged in the narrow parts of the canal, so as to occasion the necessity of their being removed by excision.

When calculi increase in size, they occasion symptoms of a more formidable character, especially in constitutions naturally irritable. The bladder will become irritable and inflamed, and will secrete an excessive quantity of mucus, accompanied with frequent desire to void the urine, from the irritation of that secretion upon the morbidly sensitive surface of the bladder. The irritation of the calculus will be felt most severely as the bladder becomes nearly empty, when its contractions upon the calculus give rise to renewed efforts, increased desire, and often total inability to void the remaining portion of urine.

The calculus, when large, will press upon the rectum, exciting tenesmus, and a sense of bearing down, with frequent and fruitless attempts to pass a stool. Frequently, also, the urine will be loaded with mucus, albuminous matter, or purulent discharges mixed with blood.

The coats of the bladder will become remarkably thickened, its capacity diminished, and at length the patient sinks exhausted by pain and suffering.

In certain instances, the bladder will sustain the presence of stones of considerable magnitude for many years, with comparatively trifling inconvenience.

The symptoms occasioned by calculi in the bladder are most obvious, when the stone lies in the neck; but they vary with the different situations in which the stone may be placed. Also great difference arises from the species of calculi contained in the bladder; and although it has been supposed that the mulberry calculus is the most painful, from its irregular surface; it must, however, be observed, that calculi of the tripple phosphates, occasion by far the greatest degree of irritation. This is probably attributable more to the irritability of constitutions prone to these formations, rather than to the physical or chemical properties of the concretions themselves.

The sound, in general, enables the surgeon to ascertain not only the presence, but the situation of a stone. Occasionally, however, it will be necessary to vary the position of the body; and I have witnessed instances, when the most expert have failed in finding the calculus, a surgeon of much less experience has touched it on the first attempt. Such cases occur when the bladder is flaccid, and the stone small.

In cases where a stone is enclosed in a sacculus of the bladder, or when adhesion to an ulcerated surface has taken place, the greatest difficulties arise; and it may so happen, that a stone easily discovered at one time, may not be so at another, in consequence of the contraction of the bladder being greater in one part than at others, forming a partially flaccid pouch, into which the stone falls, and for a time will be obscured. This accident occurs mostly in the upper region of the bladder; here the muscular fibres, particularly when the viscus is much thickened, may be observed to form a pointed pouch, from the apex of which they arise, diverging more or less as from a point or fulcrum. A stone lodged in this situation, may be firmly grasped for an hour before the contraction yields.

In certain instances, the administration of alkaline medicines will lessen the irritable state of the bladder, and consequently the degree of pain, so much, as to lead to the supposition that the stone had been dissolved: also, the bladder may contain cysts, into which the stone falls, giving rise to some of the reputed cases of their solution from alkaline remedies: it appears, however, that when a stone has once formed within the bladder, it cannot be removed by the agency of any chemical medicine.

Affections of the prostate gland are occasionally mistaken for symptoms of stone in the bladder; they are distinguished by the greater uniformity of the pain, less subject to aggravation from exercise, and are rendered clearly obvious when they can be detected by an examination per rectum. Calculi passing from the prostate gland, are so similar to lithic calculi in their appearance, that they require a chemical examination to ascertain their distinct nature; when it will be found, they are composed of phosphate of lime, and not of lithic acid: hence the necessity, in cases of doubt, of chemical analysis regulating the treatment; it having happened, that stone in the bladder has been treated for prostate calculi, and *vice versa*.

Of the various Deposits forming Urinary Calculi.

Calculi are composed of the same ingredients in the kidney, the ureter, the bladder, and the urethra; although certain combinations are more frequent in some situations than in others.

They are various in size, from minute angular crystals called gravel, to substances nearly filling the cavity of the bladder. One of the largest in the human body was taken from the bladder of Sir David Ogilbie, weighing forty-four ounces, of an elliptical form, the long axis sixteen, the short axis fourteen inches; and is preserved in the museum of the College of Surgeons.

Their form is various: in the bladder, when single, they are generally spherical; when more than one, they present flattened sides from pressure—or they may be oblong, flat on both sides, or circular—with smooth or rough surfaces. In the kidney, they conform to the shape of the pelvis and infundibula: in the ureter, they are generally oval.

They vary also in hardness and color: in hardness, from that of marble to a loose consistence easily broken to pieces; in color, from a chalky whiteness to a slate grey, or to a yellow and deep mulberry brown.

Their interior is generally formed of concentric laminæ.

Much interesting matter has been elicited from the chemical analyses of urinary calculi, relative to their formation and composition. The medical profession are principally indebted, after the important discovery of uric acid by Scheele in 1776, to the labors of Dr. Wollaston, who first discovered the nature of gouty concretions, the fusible calculus, the mulberry calculus, the cystic oxyd and calculus of the prostate; and although these discoveries were published in the philosophical transactions, at various periods, yet they were subsequently claimed by the celebrated French chemist, Fourcroy, both in his memoir in the *Annales de Chimie*, and in his *Systeme des Connoissances Chimiques*.

The collection of calculi made by Mr. Lucas during his practice in Guy's Hospital, increased by his son and successor, and presented to the museum for the benefit of the school, together with the numerous additions made by Sir Astley Cooper and others, most of which have been carefully analyzed by Dr. Marcet, and labelled according to their chemical composition, and since his time by Dr. Benjamin Babington, present an ample source of information, well worth the attention of those who are desirous of investigating this subject.

The component parts of urinary calculi hitherto detected; are lithic or uric acid, phosphate of lime, ammoniaco-magnesian phosphate, oxalate of lime, cystic oxyd, and a variable proportion of animal matter. Whenever either of the earthy matters predominate it generally imparts a peculiar character to the calculus, whence they have been classed under the following heads :—

1. Lithic calculus—consisting chiefly of lithic acid.
2. Bone earth calculus—consisting chiefly of phosphate of lime.
3. Triple phosphate calculus—consisting chiefly of ammoniaco-magnesian phosphate.
4. Fusible calculus—consisting chiefly of the two former.
5. Mulberry calculus—consisting chiefly of oxalate of lime.
6. Cystic oxyd calculus—consisting chiefly of cystic oxyd.

7. Alternating calculus—consisting of two or more of the above, in alternate concentric layers.
8. Compound calculus—consisting of various proportions of two or more of the above ingredients, so intimately mixed as not to be separable excepting by chemical analysis.

With the above may be added—

9. Calculus of the prostate gland—consisting of phosphate of lime, not distincly stratified, and tinged with the secretion of the prostate.

The varieties of calculi are generally distinguished by their physical properties; but as they are frequently of different natures, they must be sawn through to ascertain the different strata in which they may be formed. A very few tests, of a simple nature, are all that are necessary to ascertain their general chemical composition, an enumeration of which would lead me too far from the professed object of my lectures. The able essay of Dr. Marcet on calculous disorders, coupled with the valuable contents of the museum, forms an ample source of information on this subject; I shall, therefore, simply note the general physical properties of each species of calculus, by which they may be distinguished from each other in most instances.

The *lithic acid calculus* is of a reddish brown or fawn color, hard, inodorous, of an ovoid form, sometimes much flattened, smooth or studded with minute tubercles: internally they are disposed of concentric laminæ, of a crystalline texture, not unlike the section of a piece of mahogany. Occasionally they vary from a fawn to a light grey or clay color, which is in proportion to the admixture of lithate of ammonia and the phosphates.

Phosphate of lime, or the *bone earth calculus*, is of a pale brown color, of a smooth surface as if polished. Internally it is disposed in laminæ easily separable from each other; occasionally the laminæ are striated in a direction perpendicular to the surface.

The *triple calculus*, or *ammoniaco-magnesian phosphate*, is whiter and more compact than the phosphate of lime; it is not laminated, and is easily reduced to powder; its surface is uneven, and is commonly covered with minute shining crystals, which also are found between the interstices of other calculous laminæ; indeed, it never forms the whole substance of a calculus, and is more obvious from its partial depositions.

The *fusible calculus* is whiter than any other species, frequently resembling a mass of chalk. Internally they are disposed in laminæ, some of which are frequently separated by layers of the shining crystals of the triple calculus: in other instances it is of a spongy texture, in which the laminæ are not discernable. They are often of a large size, and moulded to the form of the cavity of the bladder.

The *mulberry calculus*, or *oxalate of lime*, is very hard, of a dark brown color, of a rough tuberculated surface, whence its name from its resemblance to a mulberry: its internal structure is imperfectly laminated. Occasionally this calculus is smooth and pale colored, so as to resemble the hue and smoothness of hemp seed; whence it has been supposed that the red color is owing to blood from hæmorrhage in irritation. It must be remarked, however, that the greatest irritation arises from the triple phosphate, and not from the mulberry calculus.

The *cystic oxyd calculus* resembles the triple phosphate of magnesia more than any other calculus; but they are more compact, and not disposed in distinct laminæ, but in a confusedly crystallized mass throughout. It is of a yellowish white color, semi-transparent, resembling wax, of a smooth surface. It was named by Dr. Wollaston cystic oxyd, from its combining readily with acids and alkalies, and from its being found only in the bladder in the two instances in which he had obtained specimens of it; it has, however, since been obtained distinctly from the kidney by Dr. Marcet.

Alternating calculus.—The alternating calculus may be composed of various species in concentric layers. A specimen, figured by Dr. Marcet (*p.* 18, *fig.* 8), exhibits a nucleus of lithic acid, upon which is a layer of bone earth, over which is another of oxalate of lime, and lastly the fusible calculus forms the exterior. Oxalate of lime and lithic calculi frequently alternate; also lithic strata with the phosphates; sometimes the mulberry alternates with the phosphates.

Compound calculi are more easily detected by their confused chemical analysis than by a peculiar external character: they are hard, more or less irregular, and scarcely, if at all stratified. They have no one feature by which they may be distinctly referred to either of the other species. They are of comparatively rare occurrence.

Calculus of the prostate gland are often mistaken for stones in the bladder; they are similar to lithic concretions; they vary from the size of a pin's head to that of a hazel-nut; they are more or less spheroidal, of a yellowish brown color; and all that have yet been chemically examined, according to Dr. Wollaston, consist of phosphate of lime.

When the symptoms which are occasioned by the presence of a stone have become urgent, they can only be removed by the operation of lithotomy. This operation is not in any instance warrantable, however urgent the symptoms, unless the calculus can be actually felt and heard by the process of sounding; and even then it is not, in every instance, proper for the surgeon to perform the operation, until he has examined the state of health of the patient, the probable existence of calculi in the kidney or ureter, and the presence of any organic disease which may render the result of the operation more dangerous. The most unfavorable indications arise from the presence of diseased lungs, diseased liver, albuminous urine, and such protracted diseases as have a tendency to diminish vital power.

The next consideration is the previous preparation which the patient should undergo, and for which no general plan can be adopted, as it must in every instance be regulated by individual constitution. In plethoric habits, it may be necessary to use depletion, for which blood-letting and purging are advisable; and I have found them more efficacious when conjointly employed than when purging alone has been resorted to. It is requisite also to analyze the urine, in order to regulate the medical treatment: when the acid qualities preponderate, alkaline medicines are most proper; when calcareous or magnesian salts prevail, the acids, particularly muriatic, should be administered: the object of which is, to prevent as much as possible the further deposition of calculous matter. I consider it also of great importance to prepare the patient's mind, as well as his body, for what he has to undergo: and for this purpose it is necessary to speak to him of the position in which he will be placed, and to teach him to grasp firmly the soles of his feet for short periods of time; in order in some measure to accustom him to what otherwise, at the time of operation, very generally causes the greatest terror and increased excitement. The night previous to the operation, a purgative should be administered to clear the alimentary canal; and the following morning an enema, for the purpose of securing a complete evacuation of the rectum. In very irritable habits it is also advisable, about two hours before the operation, to throw up about thirty drops of tinc. opii in an ounce of thick gruel, which materially lessens not only the muscular irritability of the parts, but produces a sedative effect, the benefit of which continues even after the operation. The surgeon should himself ascertain that every thing necessary to the operation is fully prepared before the period appointed, in order that the patient's mind may not be kept in agitation from unnecessary delay.

The patient being placed in a proper position, and secured in the usual manner, a staff is to be passed into the bladder; and the presence of the stone being ascertained, the staff is given to an assistant to hold with his right hand, standing on the left side of the patient. The surgeon then commences the operation as follows; remembering, however, that its progress consists of distinct and separate steps or stages; to each of which he should confine his mind during its progress, in order to meet the difficulties it may separately present, and not alone to the ultimate result of the extraction of the stone from the bladder.

First step—consists of an incision through the integuments and superficial fascia of the perineum, which should be regulated by the depth and breadth of the parts in each individual. This incision should commence on the left side of the perineum, in the centre of an imaginary line, drawn horizontally from the point of junction of the raphé of the perineum with that of the scrotum, to the ramus of the pubes; and should be continued obliquely downwards to the centre of a similar line, drawn from the centre of the verge of the anus to the tuberosity of the ischium. The degree of obliquity of this line depends upon the distance between the tuberosities of the ischia. In this step the following circumstances may occur: the superficial arteries of the perineum may be so much enlarged as to produce a troublesome hæmorrhage, leading to the necessity of a ligature: a fistulous abscess may possibly be laid open, or a perineal hernia be cut into; each of which occurrences point out the necessity of previous minute examination. By this incision a triangular space is laid open: bounded above, by the membranous part of the urethra; below, by the transverse muscle and artery of the perineum; on the inner side, by the accelerator urinæ; and on the outer, by the erector penis.

Second step—consists of an incision through the deep fascia of the perineum, which lays open the cavity of the pelvis. In order to effect this, the surgeon passes the fore finger of his left hand to the membranous portion of the urethra, between the bulb and triangular ligament of the pubes; by which he is enabled to direct his knife through the urethra into the groove of the staff, and from thence he continues the incision in the direction of that first made, through the deep fascia of the perineum, the fibres of the transversus perinei alter muscle, the transversus perinei muscle and artery, and some of the fibres of the accelerator urinæ.

In this step of the operation, the principal point to be observed is the opening of the urethra, which should always be made in the membranous portion: in doing which, the bulb should be carefully avoided; not only on account of its large artery, but because from the membranous portion of the urethra there is a straight passage to the bladder. It is in this incision that the surgeon may wound the rectum, which is avoided by the oblique direction of the incision towards the tuberosity of the ischium. Many surgeons defer the opening of the urethra, until the third step of the operation; but I prefer commencing the second step as above directed: first, because it is the best and most precise point whereat to commence the second incision; and, secondly, in so doing the complete division of the deep fascia of the perineum is secured; a portion of which is otherwise liable to be left as a bridle undivided, and requiring an incision for the removal of the impediment. Notwithstanding every precaution, the artery of the bulb is occasionally wounded; which, from the depth of its situation and its retraction behind the deep fascia of the perineum, cannot, under any circumstances, be secured without considerable difficulty. When this accident occurs, much time should not be lost in fruitless attempts to secure this artery, but the operation should be prosecuted; and then, by pressure, the bleeding vessel may be stopped. Should the transverse artery of the perineum, which must be necessarily divided in this step, be so large as to occasion a troublesome hæmorrhage, it may be readily tied from its superficial situation.

Third step—consists of the division of the whole length of the membranous portion of the urethra, of the prostate gland, and of the neck of the bladder. This object is effected by fixing the point of your knife in the groove of the staff, by the opening already made in the membranous portion of the urethra, at the commencement of the second step. Having clearly ascertained that the point of the knife is *in the groove of the staff without any interposing substance*, the surgeon takes the staff from his assistant with his left hand, and depresses its handle, until he brings it parallel with the axis of the pelvis, in which position it presents a direct passage for the knife into the bladder *(Vide diagram III. pl. 3.)*: and in order that this may be effected in the safest manner, before the knife is passed into the bladder, the groove of the staff and the edge of the knife should be simultaneously lateralized, or directed to the left side of the patient, at such an angle as will bring this incision in a direction corresponding to the two already made. If the gorget instead of the knife should be used to make this section, its cutting edge should in a like manner be laterally directed. In passing the knife as here described, the surgeon has the option of regulating the size of the opening, either on its entrance into the bladder, by the angle at which he holds it with the staff, or by the power which he has of enlarging the opening as he withdraws the knife; whereas, with the gorget, the opening must depend entirely upon the size of the instrument, and must be made when thrust forward into the bladder. The parts divided in this section besides the urethra, prostate gland, and neck of the bladder, are the fibres of Wilson's muscle on the left side of the urethra, and occasionally some few fibres of the levator ani, when the section of the prostate gland is complete.

The principal point to be attended to in this section is the angle at which the knife is held in the division of the prostate: if too much lateralized, the internal pudic artery is endangered; if too much in a perpendicular direction, the ducts of the vesiculæ seminales, vasa deferentia, and rectum may be wounded; while they may be avoided by the knife being directed in the course of the incisions of the two first steps, namely, midway between the verge of the anus and the tuberosity of the ischium.

If the pudic artery be wounded, no hopes can be entertained of securing it with a ligature; the best mode therefore to be adopted is, to pass a canula into the bladder, surrounding it with a firm compress of lint; by which means, as the urine is allowed to flow, the pressure may be kept for a sufficient time for the closing of the wounded vessel. The artery of the bulb may also be divided in this step, so near to the pudic as to require similar treatment.

Fourth step—consists of the introduction of the forceps, and removal of the stone from the bladder. When the bladder has been opened, it is indicated by a gush of urine, or the cessation of resistance to the knife on completing the section of the prostate. The surgeon should now take the staff in his right hand, and introduce the fore finger of his left into the bladder, to ascertain the size of the opening he has made, and, if he can, the position of the stone; being satisfied on these points, he withdraws the staff, retaining his finger within the bladder, to direct the introduction of the forceps. If the perineum should be so deep as to prevent the finger from reaching the bladder, it is advisable to use a blunt gorget as a director for the forceps. The forceps should next be introduced with the blades closed, and used as a sound to ascertain the precise position of the stone; which, being ascertained, the blades should be gently separated, in order to grasp it. In effecting this object, numerous difficulties may occur, arising from the position, form, and the size of the stone, in each of which the surgeon's mechanical judgment will be required in the proper choice of forceps suitable to the existing difficulty. Soft and friable calculi frequently crumble to pieces before they can be extracted: in such cases it is necessary to remove any portion capable of being extracted by instruments, and afterwards to inject the bladder freely with tepid water. In the extraction of the stone, too much stress cannot be laid upon the necessity of *gentleness* in the various manipulations which may be necessary; and the force which is sometimes required in the extraction of large calculi should be used not only cautiously but gradually, in order that the parts may yield to the passage of the stone, and not be unnecessarily lacerated.

Immediately the stone has been removed, and the surgeon has ascertained that no other may yet remain in the bladder, the patient should be released from his painful position, by the removal of the bandages which confined him: he should not, however, be conveyed to his bed until the hæmorrhage has ceased: which, in elderly people, frequently continues some time after the operation, from the enlargement of the veins about the prostate and neck of the bladder. When placed in his bed, the thighs and trunk should be bent upon the pelvis, so as to relax the abdominal muscles. I do not consider it advisable, as is frequently recommended, to tie the knees together, as it tends to direct any hæmorrhage which may occur into the bladder, where it may accumulate unperceived to a dangerous extent; or, at any rate, will become a source of great irritation, producing rigors and other dangerous symptoms, which will continue until the bladder expels it by its own efforts. The after treatment can hardly be generally considered, but must depend upon the constitutional and local symptoms occurring in each individual case.

I have refrained from mentioning the various instruments which are adopted by different surgeons in the performance of this operation, as I believe it a secondary consideration whether the gorget, the knife, or the bistourie cachet be used to cut into the bladder, so that the instrument be directed by the hand of a skilful operator.

I cannot, however, dismiss this subject, without adverting to the instruments invented and adopted by my colleague, Mr. Aston Key; but as he has published so full an account of them in his treatise on lithotomy, it is needless for me to say more of them here: yet in justice to Mr. Key, and in consonance with my own feelings, I must express my admiration of their complete efficacy, and of the great skill I have so frequently witnessed in his practical application of them at Guy's Hospital.

The operation for puncturing the bladder in cases of retention of urine, through the perineum, is performed much in the same manner as the operation for the stone; the great distinctions being, that in the former the incision is made in the course of the raphé; and on the membranous portion of the urethra being opened, a canula only, and not a cutting instrument, is passed into the bladder.

Practical Remarks.

The testicle, in common with the rest of the human body, is liable to various diseases, which, from the complication of its structure and importance of its function, are of great moment in a surgical point of view.

Inflammation of the testicle, which is known by the name of hernia humoralis, but which Sir Astley Cooper in his late work on this subject has much more properly named testitis, is one of the most common diseases incident to this organ. It may arise from various causes; assuming either an acute or chronic, a specific or malignant form, depending upon a peculiar constitution or specific action. This work will not admit of a minute detail of so voluminous a subject; I shall therefore merely advert to some of the diseases, concerning which the surgeon is most frequently consulted.

Acute testitis most frequently arises from suppression of gonorrhœa, and may be known by swelling, redness, and pain of the scrotum, with a sense of weight of the testicle, and a dull obtuse pain, as if the part were squeezed. The pain extends along the spermatic cord to the groin, hip and loins, often producing sickness, vomiting, pains in the bowels, and obstinate constipation. Sometimes the neck of the bladder will be affected, accompanied by much constitutional fever.

Inflammation of this character seldom or never goes on to suppuration; but should it arise from a blow, or other injury, and not from a sympathetic action, then matter more frequently forms: the symptoms above enumerated are then much aggravated, and are accompanied, in addition, with severe rigors. This disease has been mistaken for hernia. When in an acute form, it has produced a swelling in the spermatic cord, vomiting and costiveness. The resemblance is greatest to a congenital hernia, as the intestine may be then in contact with the testicle, otherwise the distinct situation of the testicle forms a simple diagnostic mark. The general history of the case, however, usually enables the surgeon to form a just diagnosis; but should there be a combination of circumstances, causing a continuance of the suspicion of the existence of hernia, a purgative enema, and the operation of an active aperient, would remove the existing doubts.

The treatment of testitis, when arising from suppressed gonorrhœa, is by fomentations to restore the discharge from the urethra; local bleeding by leeches, should be immediately had recourse to; but if they fail in reducing the inflammation, cupping the loins has a most decided beneficial effect: the bowels should be freely opened, the patient kept in a recumbent posture, and the scrotum completely supported by a cloth, kept constantly moistened by an evaporating lotion, containing the muriate of ammonia. When there is a great tendency to the recurrence of these attacks, calomel and opium are the most beneficial remedies for its removal, and may occasionally be assisted by the introduction of a bougie armed with caustic alkali.

Acute inflammation may lead to the formation of abscess in the testicle, or to a permanent disorganization of its substance. Specific inflammation may lead to an hydatid state of the testicle; and inflammation in constitutions of a malignant diathesis, may tend to the formation of scirrhus and fungus hæmatodes: in either of which cases, the removal of the organ may be required.

In the recent elaborate work upon the testis by Sir Astley Cooper, so full a treatise is given of these diseases, that I feel I cannot do better than refer my readers to his work upon that subject.

When circumstances render the operation of castration necessary, the spermatic cord is first to be secured by making an incision from the external ring downwards upon the scrotum for about two inches, and passing a needle armed with a ligature between the blood-vessels and vas deferens, the cord is to be divided below it; then drawing the retracting cord forwards with the ligature, the spermatic and artery of the vas deferens are to be secured. The surgeon then grasps the diseased testicle, and its enclosing scrotum, in his left hand, while an assistant takes the healthy testicle in a like manner, drawing it with the septum, as far as the parts will allow, from the diseased side; the surgeon then, with one sweep of the knife, removes the diseased testicle, and its enveloping scrotum. The bleeding vessels should then be secured, but the parts not dressed until a sufficient time has elapsed to secure the patient from the recurrence of hæmorrhage.

The advantage of this mode of operation, is the shortness of its duration, and the effectual prevention of the formation of troublesome abscesses, which so frequently occur when the bag of superabundant scrotum is left.

In the last operation which I performed in this manner, the wound was healed in about ten days. When the disease has produced great enlargement of the testicle, and adhesions exist to the septum scroti, great caution is required, as the septum should if possible be left entire.

A collection of water between the two layers of the tunica vaginalis, termed hydrocele, frequently leads to the necessity of an operation, for the purpose of merely evacuating the fluid, which is designated the palliative cure; or for injecting the cavity after the fluid has been drawn off, when the radical cure is intended.

It is necessary first clearly to ascertain the existence of fluid, from its semi-transparency when examined, by placing a candle on one side of the tumour, in a darkened room. The operation now generally adopted consists of a puncture with a small trocar and canula. The surgeon grasps the scrotum with his left hand, so as to secure the testicle in the back part of the scrotum, while the fluid is made to occupy the fore part. The trocar and canula having been well oiled, the point of the instrument is to be introduced with a firm but sudden force into the tunica vaginalis, at the point where the convexity of the tumour renders the testicle most distant. On the water being drawn off, the palliative cure is complete: but should the radical be intended, the surgeon should now examine the state of the testicle, which, if free from disease, he performs, by injecting into the tunica vaginalis, with an Indian-rubber bottle having a brass stop-cock exactly fitted to the canula, an injection composed of equal parts of port-wine and water, and in quantity equal to two-thirds of the fluid which has been withdrawn, and which should be secured by the stop-cock. This injection should generally be allowed to remain in the tunic five minutes; regulated, however, by the pain and irritability of the individual. It is not the expression of pain in the part, which is to induce the surgeon to withdraw the fluid; but the occurrence of the pain along the cord, and in the loins, causing nausea and sickness, which indicates the proper period to remove the injection,—which is done by turning the stop-cock, and allowing the fluid to escape through the canula.

Two circumstances are to be particularly attended to in the performance of this operation: first, to avoid injury to the testicle; and secondly, to secure the entrance of the injection into the tunica vaginalis, by thrusting the canula its whole length into the tunic at the time the trocar is withdrawn; for should the injection be forced into the cellular membrane, the scrotum will necessarily slough. When such an accident unfortunately does occur, the surgeon should make several incisions into the scrotum to evacuate the fluid, and foment the parts to allay inflammation.

The after treatment depends upon the degree of excitement produced by the above means: should irritation run very high, antiphlogistic remedies, and the recumbent posture, should be had recourse to; but if, on the contrary, there should not be a sufficient degree of pain which the surgeon considers necessary for the cure, the patient should be allowed to walk about; and even, in some cases, must have stimulants to induce inflammation. Although this is termed a radical cure, it does not invariably succeed, even under a repetition of the operation.

The old operations by caustics, setons, and incision, have all given way to the above improved mode; which was first recommended by Sir James Earle. Severe blows on the scrotum do sometimes produce an immediate swelling of the part, attended with more or less pain, depending upon the degree of injury the testicle has sustained. Sometimes leeches and the application of evaporating lotions, with a general antiphlogistic treatment, will remove these effects; but, at others, a swelling of a pyramidal form will still remain, which fluctuates to the touch, is free from pain, and, in fact, offers all the diagnostic appearances of hydrocele, excepting its transparency. This disease, named hæmatocele, is produced by an effusion of blood instead of serum, and is to be cured by a free incision into the tunica vaginalis to evacuate the extravasated semi-coagulated blood. Some surgeons have recommended that flour, or any harmless substance, should be introduced into the tunica vaginalis, to secure the obliteration of the cavity by adhesion; but I consider this practice as highly dangerous, and a remedy that is worse than the disease.

Female Organs of Generation.

The genital organs in the female are as complicated in their structure, and as various in their uses, as those of the male: they may be divided, in the same manner, into the *external* and *internal* organs of generation. Physiologically considered, they may be arranged into those which serve for copulation, those for conception, and lastly, those which contribute to the nourishment of the offspring after birth.

The external organs combine the first and third classes; while the internal are not only essential to conception, but also to the maintenance and growth of the fœtus for a determinate period.

The external organs, or those for copulation, comprehend several parts differing in their structure, use, and name; and should, therefore, be individually considered.

The *vulva* or pudendum, is the term given to all the genital organs in the female, which are perceptible externally; it forms, in fact, the entrance to the vagina, and is bounded, above, by the *mons veneris;* behind and below, by the *perineum;* and laterally, by the *labia:* for the examination of these structures, no dissection whatever is necessary.

The *mons veneris,* constitutes the soft cushion of fat which is placed upon the female pubes, furnished, at the age of puberty, with a considerable quantity of hair: there is nothing particular in reference to the structure of this part, unless we observe the density of the cellular membrane, which forms a series of tendinous bands.

The *labia pudendi,* extend downwards from the mons veneris as membranous folds, on either side the entrance of the vagina, gradually becoming thinner as they descend towards the perineum, where they unite and form a junction termed the *fourchette* or *frænulum pudendi.* The interval or rima between the labia, is of an elliptical form, produced by their inner surface which is lined by mucous membrane, while their external surface is continuous with the skin of the thighs, and is furnished with a number of hairs, and sebaceous follicles. The edges of the labia are thin and convex; their substance is made up of fat, and white strong bands of a tendinous structure, with fibres of the constrictor vaginæ muscle; vessels and nerves also enter into their composition.

The labia should now be separated, in order to expose the interior of the vulva, in which will be found the following parts; at the upper part, immediately below the diverging of the labia from the mons veneris, the *clitoris* is seen; from either side of which proceed projecting membranous folds, termed the *nymphæ* or lesser labia, which diverge inferiorly to embrace the entrance of the vagina, between which and the union of the greater labia, at the fourchette, is a space termed the *fossa navicularis;* thus much may be observed on separating the greater labia: the nymphæ should be now separated to expose the *meatus urinarius,* which is placed rather less than an inch below the clitoris. Between the meatus urinarius and the opening of the vagina, is a space termed the *vestibule.*

The *clitoris,* is a small elongated body, placed beneath the upper commissure of the labia, by which it is usually hidden; excepting when greatly developed it will project beyond them. It is composed of cellular structure, similar to the corpora cavernosa of the penis, and in the same manner is attached by two crura to the rami of the ischia, and to the pubes by a suspensory ligament. The free extremity of the clitoris terminates in a rounded imperforated extremity, somewhat resembling the glans penis, and is surrounded by a fold of mucous membrane, which is continuous with the nymphæ, but bears an analogy to the prepuce. The structure of the corpora cavernosa of the clitoris is similar to that of the penis, but appears comparatively rather more compact and dense.

It is furnished with branches from the internal pudic artery, and with filaments from the internal pudic nerve—larger in proportion to the size of the organ than in the male.

The *nymphæ, labia minora,* or *labia interna*—are two projecting duplicatures, extending from either side of the rounded extremity of the clitoris, as a ridge or fold of mucous membrane; and passing downwards, are lost on the inner side of each external labium, and about the middle of the opening of the vagina. They are thicker in their centre than at their extremities, and are composed of a spongy tissue, in which numerous blood-vessels ramify, giving them erectile power. This structure is covered by a reflection of the mucous membrane of the vulva.

On separating the nymphæ, the clitoris will be seen to form the upper commissure; about an inch below and posterior to which, is situated

The *meatus urinarius.*—This orifice presents a projecting rim, most prominent at the lower part, and is produced by a duplicature of the mucous membrane of the vulva. It is by this projecting rim that the surgeon is enabled to pass a catheter, without exposing the parts. The meatus urinarius is not more than one inch and a half in length, but much larger than the urethra of the male: its direction is slightly curved beneath the arch of the pubes, in its course to reach the bladder, presenting its concavity upwards. This passage is so readily dilatable, that calculi of considerable size may be removed from the bladder without the assistance of cutting instruments. The space between the clitoris and the opening of the vagina is termed the vestibule, in the centre of which is placed the meatus urinarius.

At the base of the vestibule is placed the *orifice* of the *vagina;* which, in the virgin state, is generally nearly closed by a portion of mucous membrane in the form of a crescent, the broadest part of which is next to the perineum: this is called the *Hymen;* and, in some instances, so completely closes the orifice of the vagina as to interrupt the flow of the menses. After it has been ruptured, its remains form several small rounded vascular bodies, termed the *carunculæ myrtiformes.*

The labia unite before the perineum in a commissure, named also fourchette or frænulum pudendi; leaving a space between the commissure and the opening of the vagina, termed the *fossa navicularis.*

The whole of these parts, comprehending the vulva, are covered by a mucous membrane, which joins the internal integuments at the free edge of the labia pudendi. It is furnished with an epidermis or cuticular covering, which is gradually lost with the increasing depth of the parts, and with numerous mucous follicles and crypts, particularly around the clitoris and internal surface of the nymphæ.

The examination of the remaining parts of the female organs of generation, is best prosecuted in a side view of the pelvis, which should be prepared in a similar manner to that of the male.

The *vagina* is a membranous passage, from about six to eight inches in length. Its canal is of an oval figure, having its long axis placed laterally. The vagina, in its direction from the vulva to the uterus, is curved, presenting a convexity opposed to the rectum, and a concavity to the bladder and urethra.

In the erect posture the vagina is bounded *above*, by the uterus; and *posteriorly*, by a small portion of peritoneum: *below*, by the vulva; *anteriorly*, by the bladder and meatus urinarius; *posteriorly*, and *inferiorly*, by the rectum and a small portion of the levatores ani; from which, however, it is separated by a mass of cellular tissue, enclosing numerous vessels.

The *uterus* is placed in the middle of the pelvis, between the bladder and the rectum, where it is suspended by its two broad ligaments, *above* the vagina and *beneath* the small intestines. It is a hollow viscus, of an oblong form, about three inches in length in its unimpregnated state: it has an enlarged upper extremity, named its fundus; a narrowed smaller inferior portion, which terminates in the vagina, named its cervix; while the intermediate space is termed its body: besides which it has two corners or angles, two sides, an anterior and a posterior surface, and an orifice to its internal cavity, termed the os tincæ.

The *fundus* is the upper part of the organ, situated above the attachments of the fallopian tubes: it presents a convex superior edge and two lateral angles, to which are attached the fallopian tubes.

The *body* lessens in size as it descends from the fundus to the cervix, presenting an anterior and a posterior slightly convexed surface, and two lateral edges, where the peritoneum from the surfaces forming the broad ligaments are not attached: this space is filled with cellular membrane.

The *cervix* is continued from the body, and terminates in the vagina, which surrounds it: at its junction with the body it is narrowed, but enlarges as it proceeds into the vagina, to terminate in a thickened rounded extremity, in which is a transverse orifice termed the *os uteri* or *tincæ*.

The *broad ligaments* which suspend the uterus, are formed of a duplicature of the peritoneum which passes from the posterior surface of the bladder, to be reflected at the point of junction of the vagina and cervix uteri: they then proceed along the anterior surface of the body of the uterus, around the fundus, to the posterior surface; enclosing in this turn, not only the uterus, but also the fallopian tubes, round ligaments and ovaria: these two layers from the fundus, and from the anterior and posterior surface, as they pass off from the sides of the uterus to the pelvis, complete the broad ligaments. The peritoneum continues to proceed along the posterior surface of the uterus to the posterior surface of the vagina; from which it is reflected upon the rectum, forming between the two organs a *cul de sac,* as it does between the bladder and rectum in the male.

The *fallopian tubes* are seen enclosed in the upper edge of the broad ligaments, extending laterally from the corners of the fundus of the uterus, four inches in length; being at first straight and small, but at their extremities becoming larger, rather tortuous, and the size of a goose-quill. At their terminations they are fimbriated; one of the fimbriæ being generally larger than the rest, and directed towards the corresponding ovarium.

The *ovaria* are placed one on each side of the uterus. between the two layers of the broad ligaments, below the fallopian tubes, and above the round ligaments; being enclosed in a proper capsule of cellulo-fibrous membrane. They have an oval form, flattened anteriorly and posteriorly. They are in size smaller than the testicles: their outer extremities give attachment to one of the fimbria of the fallopian tubes, their inner to the uterus, by ligamentous cords placed behind and a little below the round ligaments. These cords are named the ligaments of the ovaria.

The *round ligaments* arise from the superior, anterior and lateral parts of the uterus; anterior to, and a little below the attachments of the fallopian tubes. They then take their course to the internal rings, and pass through them into the inguinal canals; then through the external abdominal rings, to be lost in the cellular tissue of the mons veneris, labia pudendi, and groin.

Before removing the parts of generation from the pelvis to examine their organization, the student should observe the comparative larger size of the bladder and pelvis, the consequent straighter course of the last portion of the rectum, in the female than in the male; and the meatus urinarius, suspended by ligamentous attachments to the arch of the pubes.

Organization of the Internal Parts of Generation in the Female.

The *vagina* is composed of a thick membranous substance, which is lined by a mucous membrane, continuous with that of the vulva and uterus. Around the inferior extremity of the vagina, a plexus of veins, termed the *plexus retiformis,* is placed: it is an erectile spongy tissue, and has been named the corpus cavernosum vaginæ: it is of a grey color, and of a compact texture; thicker at the lower part, from whence it gradually becomes thinner, until it reaches the uterus. Some few fibres of the levator ani, are so connected with the sides of the vagina, as to have been designated, by some anatomists, the *constrictor vaginæ.*

The *mucous membrane* of the vagina is composed of numerous folds or rugæ, which take a regular transverse direction towards the lower extremity, but are less regular at the upper part of the vagina. These rugæ are crossed by two raphé, forming lateral columns, from which the rugæ appear to emanate. This mucous membrane is furnished with numerous follicles and lacunæ, particularly at its inferior extremity, where they are sometimes apparent to the naked eye.

The *arteries* of the vagina are derived from the internal pudic; and the *nerves,* from the sacro-lumbar plexus.

The *uterus,* or womb, is a hollow viscus, which contains the fœtus during the period of gestation. It is composed of a proper tissue of considerable thickness, which is now generally considered as muscular; a fibrous structure being traceable, both in a longitudinal and a transverse direction. It is externally covered by peritoneum, and internally is lined by an extremely delicate mucous membrane.

The *serous* or *peritoneal coat,* has already been described in the account of the broad ligaments.

In its organization, the *proper tissue* of the uterus is of considerable thickness, and of a dense and close texture; elastic, and of a greyish color. When impregnated, its fibrous tissue becomes more apparent, particularly about the orifices of the fallopian tubes, where they form in a concentric arrangement, which Ruysch has described as an orbicular muscle.

The *cavity* of the *uterus* constitutes the hollow of the fundus and body, and may be considered as the true seat of gestation: from it, however, a canal is prolonged through the cervix to the os tincæ; being slightly dilated between these two points. This canal, in the impregnated uterus, is supposed to be closed until the period of parturition. The true cavity of the uterus is of a triangular figure, with curvilinear sides: in the two upper angles are placed the minute orifices of the fallopian tubes, while the lower angle terminates in the canal of the cervix.

The *mucous membrane* lining the uterus, is extremely delicate, and firmly connected with the proper tissue of the organ: so intimately, as to be with difficulty separated from it. Its color is whitish or grey, excepting towards, and during the period of menstruation, when it is tinged with red. It presents numerous minute villosities. The appearance of the mucous membrane lining the cavity of the body and fundus of the uterus, differs from that lining the neck: being, in the latter structure, less vascular, and having numerous oblique and transverse rugæ, and two longitudinal prominent lines, which pass on the fore and back part of the neck. Between these rugæ there are lacunæ, which are more apparent towards the os tincæ, where they sometimes assume the form of distinct vesicular bodies, described in some books as the ova of Naboth, their supposed discoverer.

The uterus is supplied with numerous *arteries*, which run in a remarkably tortuous course beneath the serous coat, before they enter the substance of the viscus: they are derived from the spermatic and internal iliac vessels.

The *veins* follow the same course with the arteries: are equally if not more tortuous. They have been named the sinuses of the uterus.

The *nerves* are derived from the sacro-lumbar plexus: the *absorbents* are numerous and large, and increase in size during gestation.

The *fallopian tubes* are composed of an erectile spongy tissue, somewhat resembling the corpus spongiosum of the urethra. They are externally covered by peritoneum, and are internally lined by mucous membrane.

Their serous or peritoneal coat, is derived from the broad ligaments.

Their erectile spongy tissue constitutes the principal bulk of the tubes, and has been supposed by some anatomists to be a continuation of the substance of the uterus itself. They each contain a canal, which, along the first half, is so small as scarcely to admit a bristle; but afterwards acquires the size of a goose-quill, becomes tortuous, and again contracts before it terminates in the fimbriated floating extremity. The corpus fimbriatum, which more or less resembles a half closed hand, has been called the *morsus diaboli:* it terminates in a fissure or opening, into which the impregnated ovum is received at the moment of separation from the ovarium, and is from thence conveyed along the fallopian tubes to the uterus.

The canal of the fallopian tube is lined by an extremely thin and delicate mucous membrane: it is soft, reddish, and presents several longitudinal folds or plicæ: it has a slightly villous surface, and is found to contain mucus, although mucous follicles have not not been discovered in it. It is at the fimbriated extremity of the fallopian tube that its mucous membrane opens into the serous cavity of the peritoneum, to grasp the impregnated ovum.

The *round ligaments* seem to be for the purpose of preventing retroversion of the uterus: they take much the same course as the spermatic cord in the male. They are composed of a fasciculus of fibres containing numerous vessels, of which they seem to be principally constructed. They are of a whitish color, narrower in the inguinal canal than in any other part of their course. Some anatomists believe that a cremaster muscle gives a covering to these cords, but this is extremely doubtful: their use and structure, in fact, is but little understood. It sometimes happens, that portions of peritoneum extend along the round ligaments, into which portions of intestine may descend, and form a species of congenital hernia in the female.

The *ovaria* are enclosed in a thin cellulo-fibrous membrane, forming a proper capsule, having numerous prolongations extending from it into the parenchyma of the organ. They are placed between the layers of the broad ligaments; may be said therefore to be furnished with a serous coat. They differ in their appearance in different individuals: in some presenting a smooth, and in others an irregular surface. Their substance is composed of a soft spongy tissue, enclosing from fifteen to twenty small and transparent vesicles, about the size of millet-seed, first discovered by De Graaf, whence they have been named ovula Graafiana; around which the blood-vessels are more numerous and more minute than in the substance of the organ. They contain a fluid of a reddish color, and have smooth surfaces. It is one of these vesicles which, upon conception, bursting, yields its contents to the fallopian tube, along which it is conveyed to the uterus. A cicatrix is formed in the place of the vesicle, which has been supposed to mark the number of conceptions which may have occurred in any individual. These cicatrices have been termed the *corpora lutea*, are of a brownish yellow color; and by some physiologists it is supposed that these vesicles may burst from excessive excitement, without impregnation; and that such corpora lutea may be distinguished by their softer texture and color.

Their *arteries* are derived from the aorta, and correspond to the spermatic arteries in the male: the *veins* also take a similar course.

The Mammæ.

The mammæ are two rounded projecting glands, placed upon the anterior surface of the thorax, beneath the common integuments; connected by loose cellular membrane with the great pectoral muscles.

They are formed for the purpose of secreting milk, a nutritious fluid, destined for the support of the infant child, until its organs of digestion are capable of receiving more solid food. Their developement and function have a remarkable consent with all the changes of the uterine system. They do not acquire their full growth before the age of puberty; in young females being scarcely more prominent than in the male.

When full grown they are round, prominent, and covered with a finer and softer skin than the surrounding parts.

Towards their centre, but somewhat inclining to the lower side, the nipple is placed; a conical projecting body of a dark red color, containing the excretory ducts of the mammæ. Around the nipple is an areola of extremely delicate thin skin, also of a dark color: in this is placed a circle of sebaceious glands, which secrete an unctious fluid, to lubricate and protect the nipple from the saliva of the infant during the period of nursing.

The mammæ increase in size during the period of gestation; but towards the latter part of that period they acquire their greatest enlargement, and take on the secretion of milk, which continues many months, and appears to be kept up by the continued stimulus of the child; for when the child is withdrawn, and the milk extracted by artificial means, it soon ceases to be secreted, and the breasts decrease in size, though not to their former dimensions, being larger in women who have borne children, and remain much enlarged in those who have had many.

The areola also becomes darker in color during pregnancy and menstruation; and, with the nipple, remains darker in women after repeated conception: in young persons these parts are of a rosy tint. The nipple possesses an erectile tissue.

The child extracts the milk by means of suction, excluding the air by enclosing the nipple with its lips: it thus acts with its tongue similar to a piston of an exhausting syringe. The nipple is elongated, and the lactiferous ducts drawn out from their previously coiled position.

Organization of the Mammæ.

The mammary glands are of a whitish firm consistence, and are composed of numerous minute lobes, collected into larger masses, from whence it receives an irregular surface; but which is not perceived externally, being imbedded in adeps and cellular membrane. From these minute lobules and aggregates, the lactiferous tubes arise; and as they collect towards the centre of the gland, increase in size. They are flexuous, very extensile, and semitransparent. The larger lobes, from fifteen to twenty in number, each sends a separate duct, which varies according to the size of the lobe from which it arises, and terminates in short conical sinuses; from the summits of which proceed canals, which do not communicate together, but occupy the centre of the nipple, opening on its surface.

Sir Astley Cooper has described a structure which he considers to be connected with the developement of the nipple, and which he has termed the *mammillary gland.* It is found in both the male and female infant, placed immediately beneath the nipple. It is by this structure that the white milky fluid, which frequently flows from the nipples of newly born children, is secreted. It is evidently a separate structure from that of the substance of the mamma; but if examined in the female, it appears to be made up of the coiled lactiferous tubes, as they are passing to terminate in the nipple.

The *arteries* of the mammæ are numerous, and are given off from the thoracic, axillary, intercostal, and internal mammary; having *veins* corresponding to the arteries, excepting some few which follow a subcutaneous course.

The *lymphatics* are numerous, and terminate in the axilary ganglia.

The *nerves* are from the brachial, plexus and intercostal.

The milk of the human subject differs from that of other animals, in having more saccharine matter, and less curd, and in not yielding butter. The curd increases in proportion to the time after delivery. The milk may be considered as one of the most compound of the animal secretions: it contains, besides hydrogen, carbon, oxygen and a small quantity of azote, muriate of soda, muriate of potash, phosphate of lime and other salts. The presence of muriate of potash in milk, and its not being found in the blood, has led to the supposition, that the constituents of the milk are furnished by the absorbent system: the salts of potash being found abundantly in the chyle formed from vegetable substances. We may observe, therefore, that the milk contains all the essential elements of nutrition for the infant; when it is itself incapable of the powers of assimilation, in proportion to the great rapidity of its growth.

Practical Remarks.

The female organs of generation are not liable to so complicated a series of diseases as the male, in consequence of the urinary apparatus being more distinct; they are, however, from the earliest periods, subject to various malformations, and diseases requiring surgical aid for their relief.

The *vagina* is liable to congenital malformations, the most frequent of which is an imperforate state, either produced by the mucous membrane forming a *cul de sac* over the orifice of the vagina, so as completely to close the opening; or in other instances by a thickening or accretion of the sides of the vagina, so that the whole passage is wanting.

These malformations frequently escape the notice of parents, and the surgeon is not consulted until that period of life when they occasion a mechanical obstruction to the menstrual discharge, and produce a train of symptoms very similar to those of pregnancy: such as, in addition to the absence of the menstrual discharge, flatulency, attended with eructation, morbid appetite, nausea, and occasional vomiting on the change of position from the recumbent to the erect posture, enlargement of the mammæ, and swelling of the abdomen, and various other uterine sympathies. The nature of these cases are difficult to determine, without an examination, when the malformation of the parts immediate elucidates their origin, and points out the means of relief.

If the imperforation depends merely on the mucous membrane it will be denoted by the protuberance of the membrane, forming a convex fluctuating tumor; this is readily relieved by a free incision, from which the collected discharges will be evacuated; this must be followed up by constitutional remedies, which generally completes a cure.

When the imperforation is produced by a closure of the canal and consolidation of the vagina, the means of relief are attended with greater difficulty, and with consequences of a dangerous character; this arises from the depth and thickness of the parts to be cut through, and their proximity to important organs, which are, in consequence, liable to be wounded. Here a correct knowledge of the contents of the female pelvis, and the relative position of the parts contained, can alone enable the operator to direct his knife in the proper course, from the vulva to the os tincæ, for the purpose of evacuating the collected fluid.

My friend, Mr. Herbert Mayo, met with a case of this kind, in which the whole length of the canal of the vagina was obliterated, and which he relieved by passing a trocar in the direction of the uterus, and then directed a gorget into this opening in order to establish the canal. This patient completely recovered, and afterwards had a family.

From lacerations or ulcers, a similar effect is produced to that of malformations, from cicatrices, which, in the process of reparation, entirely close, or partially contract the canal, so as to render either dilatation by the use of sponge tents, or incision necessary, for the reestablishment of the natural size of the canal.

The *clitoris* is sometimes so large, from an inordinate developement, without any specific diseased action, as to require partial excision for the removal of this inconvenience. It is also subject to malignant disease, particularly of cancerous affections and ulcerations, which render its removal necessary. For the performance of this it is proper to place the patient in the same position as for the operation of lithotomy. A ligature will be required to secure the artery of the clitoris, which is in proportion larger than that of the penis.

The *nymphæ*, like the clitoris, are sometimes inordinately large, and this may occur to either one or both, so as to produce a projection beyond the external labia. The inconvenience arising from these enlargements require a similar treatment to that of the clitoris.

The *uterus*, more particularly the neck, is liable to malignant diseases, and these most frequently occur either to unmarried, or to women who have never borne children. The principal reason for the more frequent occurrence of these diseases in such persons is probably owing to the important functions of the uterus never having been called into action. Of late years, where the disease has only been in the neck, the parts have been extirpated with complete success; this has led surgeons to perform the more formidable operation of extirpating the whole organ; but from the unfavorable results which have followed,—only two out of twelve having recovered, and they only surviving, one twelve, and the other eleven months,—and from the severe constitutional shock experienced by the loss of this organ, so violent as generally to destroy life in a few hours after the operation, it is more than probable that in future it will be entirely abandoned.

The mode of removing the neck of the uterus is simple: the patient being placed in the position for the operation for the stone, a speculum vaginæ is introduced to widen the vagina, so that the neck of the uterus may be seized with a double hook, and drawn forwards into the vagina, so as to admit of the excision of its neck; but little bleeding usually follows. I have, myself, seen Dr. Blundell remove the whole organ, in which operation he evinced so much dexterity and anatomical knowledge, that I cannot pass over his mode of operating without noticing it.

The patient was placed on a bed of a convenient height, in the position adopted in ordinary delivery; the operator, kneeling by the side of the bed, introduced the middle and fore finger of his left hand, with the blade of a curved scalpel secured between them, at the same time exploring with the fore finger, he ascertained the point at which the peritoneum is reflected from the vagina to the rectum, where he made an opening by insinuating the knife through the posterior wall of the vagina, into the *cul de sac* of peritoneum. This opening into the peritoneal bag was only sufficiently large at first to admit the point of the fore finger, when the knife was laid aside, as the intestines were immediately felt pressing against the admitted finger. The opening in the peritoneum was then enlarged by dilating it sufficiently with the fore finger so as to admit the middle, when the whole hand was passed into the vagina, (which in this case the organ readily admitted) and enabled the operator to place the tips of the fore and middle finger upon the fundus of the uterus, which he then retroverted, so as to bring it into the palm of his hand; then gradually withdrawing it into the vagina, through the opening he had made in the posterior wall, he there held it while he divided close to the uterus, the fallopian tubes, broad and round ligaments, which still held it in connection with the abdominal cavity; then drawing the uterus as far forwards as possible into the vagina, he separated it from that organ by careful incisions, so as to avoid the bladder and ureters.

The patient lost a very small quantity of blood during this operation, and bore it without evincing a great degree of pain; her nervous system, however, appeared to have suffered a greater shock than usually occurs where so little pain is expressed. This patient survived the operation twelve months, when she died from constipation.

The *ovaria* are liable to malignant diseases, both from schirrous tumors and fungus hematodes. For the removal of these complaints the operation for extracting the ovary has been resorted to ; but the difficulty of forming a just diagnosis of the disease, the danger attending the opening of a large serous cavity, and the impossibility of prejudging the extent of the morbid adhesions the organ may have formed, together render the propriety of such an operation doubtful, excepting only under the accumulation of some fortuitous circumstances, which may warrant the surgeon in its performance.

This operation can scarcely be described, and must vary with the size and direction of the developement of the tumor. The abdomen should be opened in all cases that will admit of it, in the line of the linea alba, in order to avoid wounding the branches of the epigastric artery ; the extent of the opening must be regulated by the size of the tumor.

In consequence of the exposure of so large a cavity the temperature of the room in which the operation is performed is always a matter of considerable importance ; and as the intestines generally protrude during the operation, cloths, wrung out in warm water, should be had in readiness to enclose them as long as may be necessary.

The ovaria are also liable to large dropsical accumulations, in which the fluid is contained sometimes in one cavity, at others in separate cells. At the commencement of this disease it may readily be distinguished from dropsy of the peritoneal cavity by the situation of the tumor being on one side of the mesian line; but as the accumulation of fluid increases the abdomen becomes generally distended. At this period, however, the diagnosis is usually sufficiently obvious, from the patient's constitution being in ovarian dropsy but little impaired, and suffering merely from the inconvenience of the weight of the tumor: while in peritoneal dropsy the health is usually much impaired, and generally connected with organic disease of the liver, or some other important organ. When ovarian dropsy has accumulated to an extent beyond which it cannot be borne, then, and not until then, should the surgeon recommend the evacuation of the fluid by operation; after having employed every medicinal means likely to prevent its accumulation, or to induce its absorption: such as diuretics, mercury, and tartarized antimony, to which may be added friction and pressure.

These accumulations are evacuated by the operation of paracentesis abdominis; and generally, as in common dropsy, the trocar is to be introduced in the linea alba, midway between the umbilicus and pubes; but sometimes the tumor is placed so much on one side as to require a lateral opening. The usual position in this operation is the sitting posture, but I should always recommend the recumbent, as the patient is then saved from the distressing symptoms which arise from the change in the position of the abdominal viscera, as the water becomes evacuated. I have had constructed, to facilitate the evacuation of the water in this position, an elastic gum tube, three feet in length, armed with a stop cock at one end, while the other is made with a brass mouth, nicely to fit the canula. This tube can readily be directed over the side of the bed to a convenient vessel to receive the fluid.

In ovarian dropsy the trocar and canula should always be used, and not the canula recommended to be introduced through an opening made by a lancet, as the fluid is frequently of so viscid a consistence that it will not flow through the small apertures of such a canula.

This operation is to be considered as merely palliative, for the disease almost invariably returns, notwithstanding all the means which have been adopted in the various attempts made to effect a cure.

My friend, Mr. F. Toulmin, of Hackney, attended a woman, aged thirty-four years, who had an ovarian dropsy, and was, at the same time, in an advanced state of pregnancy. Fifty-two pints of water were drawn off, and in thirteen hours after she was delivered of a fine female child, which lived, did well, and was suckled by its mother. In two months afterwards the same quantity of fluid was again drawn off: after which every two months the operation was repeated until her decease, which was in eighteen months from her delivery.

The *mammæ*, both from their structure and function, are particularly liable to a class of diseases peculiar to the female: in the male, however, the nipples are subject to some of the diseases incident to the female.

The diseases of the breast may be divided into three classes:—those which are caused by external injuries, those which are connected with the function of the gland, and those which arise from specific constitutional diseased action.

Of the first class:—Common inflammation, arising from external violence, is indicated by pain, redness and swelling, similar to inflammation in other parts, and requires the same constitutional and local means of treatment: but the breast, like other glandular structures, is slow in the progress of its diseased changes, and equally tardy in the process of restoration.

Inflammation, therefore, frequently runs into a chronic form, inducing a general enlargement and induration of the gland, which may be relieved by the occasional application of a few leeches and emollients. Even in this simple form of disease the constitution so frequently sympathises, that tonics may be required; and if the uterine actions are irregular, steel may be beneficially administered.

When inflammation, induced from a blow, or other external violence, terminates in the formation of an abscess, it is more frequently in the chronic than in the acute form, accompanied by symptoms so insidious that the presence of an abscess has frequently escaped the surgeon's notice. In this state there is considerable difficulty in forming a just diagnosis, particularly when the history of the disease has not been well ascertained, for the tumor presents a very indistinct fluctuation, a general surrounding hardness, and puts on many of the appearances which are of a malignant character. I have known a patient recommended by a skilful surgeon to submit to the operation for the removal of the breast, when another, who had paid particular attention to this class of diseases, by the puncture of a lancet at once discovered its true nature, and saved the patient from this painful operation; hence the necessity, in all doubtful cases, of puncturing the tumor, to ascertain the possible presence of matter, before proceeding to extirpate the breast.

Inflammation of the breast is frequently excited in young females of a full plethoric habit, immediately after the age of puberty, and may occur as late as the age of thirty years. This inflammation will sometimes induce an irritable state either of the whole gland, of one or two of its lobes, or the formation of a small tumor, which is very prominent, as if superadded to the substance of the breast. In either of these cases the slightest pressure causes considerable pain, extending into the axilla, and in the course of the inner cutaneous nerve; these tumors are usually attributed to the state of the constitution, but, in fact, are connected more with changes in the uterine system than with a particular constitutional diathesis. Leucorrhœa is often a cause of this complaint, which cannot be removed until the leucorrhœa is suppressed, when they will frequently simultaneously subside.

For the treatment of the irritable breast great care must be taken not to diminish the strength of the patient, as you cannot diminish constitutional power without increasing nervous irritability. Plasters of equal parts of soap and belladonna, conium poultices, evaporating lotions, either separately or mixed with poultices, may be variously recommended, as local applications; if from these remedies relief is not obtained, leeches are occasionally necessary. As constitutional means, calomel and opium should be prescribed, to diminish irritability; and ammonia, rhubarb, with bitter infusions, to improve the general system. This treatment must be varied according to the state of the uterus, or the existence of leucorrhœa.

The next disease connected with the function of these organs is that which is commonly named milk abscess; this arises either from the suppression of the secretion, from cold, from the great distention of the organ when its secretion is superabundant, from the obliteration of one or more of the lactiferous tubes, or from malformation of the nipple. The worst form is when induced from the first of these causes, which leads to a great degree of irritative fever, and requires the most active constitutional and local remedies. When it arises from the second cause, relief is almost invariably obtained by the milk being withdrawn either by the mouth or other mechanical means, and by regulating as much as possible the secretion of the gland. From the third cause, the tumors which form present fluctuating prominences, opposite to the obliterated tubes, and generally near to the nipple. When such tumors occasion great irritation, they must be opened with a lancet, otherwise these accumulations go on to produce troublesome abscesses. These tumors generally contain pure milk.

The malformation of the nipple, may either be such as admits of a remedy or not. When in a flattened state, the nipple may by degrees be elongated by mechanical means, so as to render it capable of performing its natural function ; but when imperforate, or, as sometimes happens, when entirely wanting, there seems to be no remedy, unless, in the first instance, perforation with a needle be attempted : as the obliteration may arise from the mucous membrane of the canal only, and not from an accretion of the whole of the ducts themselves.

From the existence of the hydatid disease of the breast occurring only from about the age of twenty-five to the cessation of menstruation, I feel inclined to class it with the functional diseases of the organ ; although, during this period, it may be occasionally induced from the inflammation following local injuries. From the third class we appear to have every reason to separate it, as its removal by excision effects a radical cure, and proves that it does not depend upon a constitutional diathesis. The diagnosis of this complaint is sometimes difficult, as it occasionally puts on the appearances of the fungoid disease ; but the unimpaired state of the patient's health, and the general history of the progress of the disease, in most instances points out its true nature.

Cancer and fungus hæmatodes constitute the third class of disease incident to the mammæ, and depend upon a peculiar malignant diathesis.

When these diseases are once established, little hope of a cure can be entertained either from the use of medicines or from their excision, as we know of no remedy which can alter the constitutional exciting cause, and which remains when the tumors themselves are removed.

Fungus hæmatodes, not inappropriately termed soft cancer by the older writers, usually occurs from the age of twenty-five to the age of thirty-five, but occasionally as early as sixteen ; whereas, cancer is a disease of a much later period, rarely putting on a serious form until after menstruation has ceased. May not the rapidity of the growth of the former, when compared to the latter disease, depend more upon the period of life at which it occurs, than on any specific difference of action? I shall not enter into a minute detail of the appearances assumed in these diseases, as there are so many works extant upon the subject, that it is wholly unnecessary here.

The removal of tumors from the breast consists of a simple piece of dissection. Care should be taken to leave sufficient integument to close the wound, and on the other hand, not too much, so as to lead to the formation of abscesses. During the operation if large blood vessels are divided, they should be immediately secured, unless they are so situated as to be conveniently commanded by an assistant; smaller vessels need not be secured until after the removal of the tumor. In these extirpations great care should be taken that no diseased portions are allowed to remain, in order to prevent as much as possible the return of the complaint, which, however, with every possible care, too frequently occurs, from the tendency of such constitutions to regenerate the disease. The after treatment consists in the administration of alterative medicines, recommending, at the same time, change of air and scene, in order to divert the action of the mind as well as to change that of the constitution.

In conclusion of this subject it may be remarked, that at the advanced periods of life this disease is so slow in its progress, that the patient is more likely to survive for a greater period the effects of the disease, than when subjected to the operation.

LECTURE XXV.

OF THE THORAX AND ITS CONTENTS.

The cavity of the thorax, placed between the cervical region and the abdomen, contains the organs of respiration with their investing membranes the pleuræ; the heart, the principal organ of the circulation of the blood, with its investing membrane the pericardium; and the mediastina, with their contents.

The structure of this cavity has already been described, with regard to its bony parietes (*Vide Vol. I. p.* 88.), and with respect to its muscular parietes. (*Vide Vol. II. p.* 166.) It is here therefore only necessary briefly to recapitulate, that this cavity is formed principally of a bony structure, which gives it great strength, and of elastic cartilage, which, with the vital energy of numerous muscles, contribute to effect its alternate enlargement and contraction, and consequently the simultaneous action of the lungs during respiration.

We have hitherto merely considered the cavity of the chest in reference to its bony and muscular parietes; we must now, however, enter into such considerations as will point out, how perfectly this cavity is constructed for the various purposes for which it is employed. Thus, in the process of deglutition, the food, in its passage from the pharynx to the stomach, passes through the cavity of the thorax; and when assimilated, is returned in the form of chyle through it, to enter the venous system at the lower region of the neck. The air we breathe also has its ingress and egress in respiration; while the blood we circulate emanates from the heart in this cavity, to supply the whole of the body, from whence it is returned to it by the venous system. Numerous important nerves also traverse this cavity, in their course to various ultimate distributions. Hence it will be readily seen, that a correct knowledge of the various openings into the cavity of the chest is a point of considerable anatomical importance.

At the apex of the cone, or upper part of the chest, we find an opening which is bounded behind, by the first dorsal vertebra; before, by the upper piece of the sternum; and laterally, by the first ribs. This opening has a slanting direction from behind and above, to before and below. The parts passing into this opening are the œsophagus and trachea, the pneumogastric, sympathetic and phrenic nerves, the venæ innominatæ, and internal mammary arteries: while the parts passing out are the arteria innominata, the left carotid and left subclavian arteries, the thoracic ducts, the first dorsal and the recurrent laryngeal nerves, portions of the pleuræ, and the longi colli muscles. These important parts are protected from compression by the mode of articulation of the two first ribs, which admit of the elevation of the sternum, and consequent enlargement of the opening, but does not allow of any diminution.

The base of the cone, or lower part of the chest, is entirely formed of the diaphragm, which is placed in a slanting direction, precisely the reverse of that of the upper opening, namely: from before and above, to behind and below. Hence the perpendicular axis of the chest is much greater posteriorly than anteriorly.

The diaphragm, which forms the partition between the chest and the abdomen, is perforated by three principal openings for the passage of several important parts. On the right side of the centre of the tendon of the diaphragm there is a triangular opening, for the passage of the vena cava ascendens, accompanied by a few twigs of the phrenic nerve. Between the crura of the diaphragm, and in the mesian line of the body, an opening is left; bounded posteriorly by the lumbar vertebræ, which transmits the aorta, vena azygos, and thoracic duct. Above, and rather to the left side of this opening, a third space is formed by the decussation of the two crura of the lesser muscle of the diaphragm, through which the œsophagus passes, and the par vagum; while the sympathetic and splanchnic nerves pass through the substance of the lesser muscle itself, in their passage to the abdomen. Of these three openings, that which transmits the œsophagus is the only one so constructed as to admit of the compression of the organs passing through it, and which compression assists in the propulsion of the food from the œsophagus into the stomach.

We may now proceed to the examination of the interior of the thorax, and to describe the splanchnic membranes which cover the organs it contains; after which, we shall continue with the thoracic viscera individually.

In order to open the thorax, so as to demonstrate the pleuræ, the intercostal muscles should be carefully removed; and then sawing through the six superior ribs just anterior to their angles, and dividing their cartilaginous extremities, they should be raised, taking care not to wound the pleuræ. The thin semitransparent membrane which now presents itself to view, is the pleura costalis; which name it bears, where it forms a lining to the ribs and intercostal muscles. There are two distinct pleuræ in the cavity of the chest, each forming a separate closed serous bag, occupying the lateral portions of the thorax. In the centre, between the two bags, spaces are left, which are named the mediastina. The lungs are surrounded by the pleuræ, precisely in the same manner as the abdominal viscera are by the peritoneum: and it is at this period of the dissection that the student should trace the reflections of these membranes.

The subject being in the horizontal posture, and the ribs having been removed as before described, the student should tear or cut through the pleura costalis, by which means he exposes the lung on that side of the chest, as if free within the cavity; but, by examination, he will discover that it is surrounded by pleura, precisely in the same manner as, on opening the cavity of the abdomen, the small intestines are found to be surrounded by the mesentery.

The reflection of the pleura may be traced commencing from the side of the sternum, from which the layer on the one side converging towards that on the other, leaves a small space between the two, termed the anterior mediastinum. Each layer passes backwards upon the pericardium, to the anterior surface of the pulmonary vessels , proceeds along them to their entrance into the lung ; at which point the membrane is reflected from the vessels upon the anterior half of the concave surface of the lung, winds over the acute anterior edge of the lung, covers the external convex surface ; extending upwards to the apex, and downwards to the base of the organ ; winds around its posterior obtuse edge, covers its posterior concave surface, and gaining the point where the vessels enter, passes from the lung to their posterior surface ; running then to the under surface of the pericardium, upon which it has a tendency to approach the pleura of the opposite side : from thence it is directed to the side of the spine, forming one side of a triangular space, which is termed the posterior mediastinum : from the side of the spine it passes to the heads of the ribs, covering the ganglia produced by the union of the sympathetic and intercostal nerves ; it then proceeds along the inner surfaces of the ribs and intercostal muscles, and passes to the side of the sternum—from whence we commenced our description.

The sternum should now be lifted up, after dividing the cartilages of the ribs close to their bony parts, on either side, and the connection of the diaphragm to the ensiform cartilage. The pleura will then be observed to form a complete partition between the right and left lung : the lung on the left side is, however, smaller, than that on the right, in consequence of the space in the mediastinum occupied by the heart, and its investing pericardium, being situated more on the left than on the right side.

The *anterior mediastinum* is a triangular space between the pleura, in front of the pericardium and behind the sternum: opposite the fourth rib it alters its perpendicular direction, and is inclined to the left, terminating opposite the sixth rib. Above and below the heart, the anterior mediastinum extends the whole depth of the chest from the sternum to the spine; but in the middle part only, from the sternum to the pericardium.

The contents of the anterior mediastinum are, the thymus gland, small absorbent glands, and absorbent vessels, invested in loose cellular membrane.

The *thymus gland*—the use of which is entirely unknown—appears to be wholly connected with the economy of the fœtal state. It is a soft, lobular, glandular body, of a yellowish or whitish color, which, at that early period, occupies a space extending from the thyroid gland, nearly as far as the diaphragm, within the anterior mediastinum. From the fœtal period it gradually diminishes in size, until, in the adult, it is nearly absorbed; and in old persons, can scarcely be distinguished from the cellular membrane in the mediastinum. Its figure is oblong, its upper and lower extremities being unequally divided into two portions by a fissure, which leaves the portions on the right side thicker and longer than those on the left. A sulcus extends from the upper to the lower fissure, along the anterior surface of the gland.

It is covered by a thin capsule, which sends prolongations into its substance, dividing it into several lobules of unequal size. These lobules are filled with vesicles, which appear to possess a general communication, in which a milky viscid fluid is detected. An excretory duct has not been discovered; its blood-vessels and lymphatics are, however, very numerous. The arteries arise from the internal mammary, inferior thyroid, bronchial, mediastinal and péricardiac, and are accompanied by corresponding veins. Its nerves are derived from the pneumogastric, inferior cervical ganglia and diaphragmatic nerves.

Practical Remarks.

The size of the thymus gland in young children, renders the operation of tracheotomy infinitely more difficult and dangerous than at a later period: ascending as it does from the thorax, sometimes even as high as the thyroid gland, it so covers the whole length of the anterior surface, that the surgeon has no space left to make an opening in the trachea, without wounding this gland; still, however, those urgent circumstances which usually render this operation necessary, leaves the surgeon no choice as to the necessity of its performance, with a care, however, which must be in proportion to the increase of difficulty.

The centre of the mediastinum is occupied by the heart, and its investing membrane the pericardium.

The pupil has here to observe the attachments of the pleura to the pericardium, and the direction of the long axis of the heart; the phrenic nerves, taking their course between the two pleuræ and pericardium, on either side, towards the diaphragm: the course of the large arteries arising from the heart, and of the veins passing to it; and particularly the course of the left vena innominata, crossing in front of the arch of the aorta, to terminate in the descending cava. The minuter particulars of the position and relative situation, and whole anatomy of the heart and arteries, will be given when treating of the circulating system.

The *posterior mediastinum* is to be exposed by raising the right lung, and drawing it over as much as possible to the left side of the chest; and by cutting through that portion of the pleura which is reflected from the posterior surface of the right pulmonary vessels, and concave surface of the right lung to the spine. The space thus exposed is of an irregular triangular figure, its base being formed by the spine, its apex, in the centre by the pericardium; but above and below it is continuous with the anterior mediastinum, and laterally with the two pleuræ.

Its extent is from the upper part of the third to the seventh dorsal vertebra. It contains lying on the spine through its whole course the aorta to the left, the vena azygos to the right, and the thoracic duct between the two, while the œsophagus and par vagum pass in their front. Immediately at the commencement, or upper part of the posterior mediastinum, the division of the bronchi may be seen.

The pupil should here observe, that the œsophagus does not take a straight course through the posterior mediastinum: at the upper part, it is placed to the right of the aorta; in the middle, immediately in front; and below, to its left side. The par vagum, in their course upon the œsophagus, are so placed that the right is on the posterior, and the left on the anterior surface of that organ.

We need not further mention the particulars of the other organs contained in the posterior mediastinum, as they will be separately described with the systems to which they belong.

At this period of the dissection, both the pulmonary and arterial systems equally present themselves to our notice; and are each so important and so intimately connected, that a difficulty arises, both in an anatomical and physiological point of view, which to consider first: I shall, however, pursue the usual course of my lectures, and commence with the organs of respiration.

Anatomy of the Organs of Respiration.

The best opportunity of observing the relative position of the blood-vessels of the lungs now offers itself; for which purpose the pleuræ should be separated completely from the pulmonary vessels, and the pericardium removed from the heart. From the anterior surface and right side of the heart the pulmonary artery arises, taking its course as a single trunk upwards, slightly backwards and to the left, as high as the concavity formed by the arch of the aorta; at which point may be observed an impervious cord connecting these two vessels, which is the remains of the fœtal ductus arteriosus. Here the pulmonary artery divides into a right and a left trunk: the right takes its course behind the ascending aorta, behind the descending or superior cava, in front of the right bronchus, which it somewhat embraces, and enters the right lung, dividing into three principal branches.

The *left* pulmonary artery, which is shorter but larger than the right, passes below the arch, in front of the descending aorta and its corresponding bronchus, to terminate in the left lung, dividing only into two principal branches. These vessels afterwards ramify in the lungs, in a manner which will be explained with their intimate parenchyma.

The *pulmonary veins* arise from the ultimate distribution of the pulmonary arteries, and pass from the lungs on either side, forming two large vessels: a superior and inferior right, and a superior and inferior left pulmonary vein.

The *superior right* pulmonary vein emerges from the right lung, below the right bronchus, and passes obliquely downwards, to terminate in the upper part of the right side of the left auricle of the heart.

The *inferior right* pulmonary vein emerges from the inferior lobe of the right lung, and is directed obliquely upwards, to enter the inferior part of the right side of the left auricle of the heart; the right pulmonary artery being placed between these two veins.

These veins are much concealed by the vena cava, and right auricle of the heart.

The *left pulmonary veins* take much the same course, are however more exposed to view, and less separated from each other; and enter on the left side of the left auricle of the heart, in a similar manner to those on the right side.

The heart should now be removed from the body, in order to expose more effectually the division and the course of the air-tubes to the lungs. In the consideration of the air-tube, we necessarily refer to its natural divisions into larynx, trachea, and bronchi; and as the organization and function of the lungs equally depend upon the structure of these parts, it is sufficiently evident that they should be described before the lungs themselves; although we must leave the thorax for a time, for that purpose.

Anatomy of the Larynx.

The *larynx* forms the upper and larger part of the windpipe; it is situated on the anterior part of the middle of the neck, reaching from about the upper part of the fourth to the lower part of the fifth cervical vertebra. It is bounded above, by the os hyoides; below, by the trachea; in front, by the thyroid gland; laterally, by the carotid sheaths; and behind, it is separated from the spinal column by the pharynx.

The larynx is principally composed of five cartilages: the upper is the *thyroid* or *scutiform*, which is of a quadrilateral figure, placed on the anterior part of the neck, forming a prominence particularly observable in the male adult.

Immediately below the thyroid is placed the *cricoid* cartilage, which differs from the thyroid, being completely annular in its form. It occupies the lowest part of the larynx, and is attached to the first ring of the trachea. These two cartilages principally maintain the form of the larynx, and its constant open state for the transmission of the air; serving also in some measure for the alterations of the voice, in a manner that will afterwards be described when speaking of the particular motions of the larynx.

Above and at the posterior part of the cricoid, two other small cartilages are articulated, which are termed the *arytenoid.* They rise up above the level of the cricoid, so as to form a concavity, which may be said to resemble a portion of the circumference of a basin, in conjunction with the fore part of the thyroid cartilage; and are endowed with a motion upon the cricoid, which tends to open the glottis or aperture of the larynx. But it is not only these cartilages which tend to alter vocal sounds, there being other structures to produce such changes.

The *epiglottis* is the fifth cartilage of the larynx; so, at least, it is usually termed; but in fact it is fibro-cartilaginous, having a considerable quantity of fibrous tissue entering into its composition, from which it derives its peculiar physical property—elasticity. It is connected by a middle ligament, to the base of the tongue; by two lateral ligaments, to the cornua of the os hyoides; and posteriorly, by two others, to the arytenoid cartilages. Its form is irregularly conical, and is made to overlap the glottis in the act of swallowing, by the tongue thrusting it backwards, and the larynx being raised at the same time, by the action of some of the muscles of deglutition.

These five cartilages are connected with each other by ligaments, and are destined to be moved either by muscles common to the cartilages, as a whole organ, or upon each other by muscles proper to individual parts.

The larynx is supplied with arteries, veins and nerves, and its interior is lined by mucous membrane.

The *thyroid cartilage* is the upper and largest of the five cartilages of the larynx: it resembles in form the breast-plate of a cuirass, having a prominent vertical line down its centre, which is produced by the junction of two plates extending obliquely backwards, to form the sides of the cartilage, leaving a large open space posteriorly.

This cartilage presents an external and an internal surface; an upper, an inferior, and two posterior edges; and posteriorly, two superior and two inferior angles, which are prolonged, and are termed the superior and inferior cornua.

The *external* or *anterior surface* presents, in the middle line, a perpendicular prominence, which projects more or less in proportion to the acuteness of the angle formed by the union of the two lateral plates, and is always more marked above than below, and is termed the pomum Adami. The sides are slightly concave, and are marked by a line which passes from the upper part of the posterior edge obliquely downwards and forwards towards the middle of the lower edge, this gives attachment to the sterno hyoidei and sterno thyroidei muscles. Posterior to this line, the cartilage is marked by the attachment of the constrictor pharyngis inferior; and is sometimes perforated by a foramen, for the passage of blood-vessels.

The *internal* or *posterior surface* forms an angular cavity, corresponding to the anterior surface. In the middle sulcus, formed by the union of the two plates, there is a slight roughness below, for the attachments of the vocal cords. On either side, from the middle of the lower parts of these plates, the thyro arytenoidei muscles arise; and posterior to these, the crico, arytenoidei laterales are attached.

The *upper edge* presents a curvilinear or cordiform appearance; having a deep notch in the centre, which is less marked in the female than in the male; and gives attachment, along its whole length, to the thyro hyoid ligament.

The *lower edge* gives attachment to the crico thyroid ligament, and is marked by two tubercles, in which the two oblique lateral ridges terminate. The lower edge also gives attachment to the crico thyroidei muscles.

The *two posterior edges* are perpendicular and obtuse; and where they are attached to the superior and inferior edges, they form angles, which are prolonged into processes termed the *cornua*, and of which the upper are larger than the lower.

The *two superior cornua* are connected by round ligaments to the os hyoides; the *two inferior*, by smooth concave surfaces on their inner side, to the cricoid cartilage; the two posterior obtuse edges give a partial insertion to the stylo and palato pharyngei muscles.

The *cricoid cartilage* is the thickest of the larynx; and instead of leaving an open space behind, like the thyroid, there presents its largest surface; while anteriorly it is small, and forms a complete annular structure. Its figure is extremely irregular; but in it may be distinguished an external and an internal surface, a superior and an inferior circumference.

The *external surface* is very narrow anteriorly, and gives attachment to the crico thyroidei muscles. As it passes backwards, its sides become broader, which are furnished superiorly with two polished articulating surfaces, for the attachment of the inferior cornua of the thyroid cartilage. From the sides it continues to enlarge, until its broadest surface is formed quite posteriorly, where it presents a quadrilateral figure, pointed above and straight below, divided by a mesian prominence, on each side of which there are roughened concave surfaces, for the attachment of the crico arytenoidei postici muscles.

Its *inner surface* is smooth, and is lined by the mucous membrane of the larynx.

Its *superior circumference* may be divided into an anterior and a posterior part: the anterior, forming two thirds, is attached to the crico thyroid ligament; while the posterior rises higher up in the space left by the diverging plates of the thyroid, and presents a middle elevation, on each side of which is a smooth convex articular surface, inclined outwards, to receive the corresponding concave base of the arytenoid cartilage. A small roughness is usually described anterior to these articular faces, into which the crico arytenoidei laterales are said to be inserted; but the fact is, they are only inserted into the bases of the arytenoid cartilages; for it must be obvious, that their insertion into the cricoid, from which they arise, would prevent their action.

The *inferior circumference* is nearly horizontal in its whole extent, and is attached to the first ring of the trachea, by a broad intervening ligament.

The *arytenoid cartilages* are two in number, and are placed above the cricoid, at the upper and back part of the larynx. Their form is somewhat of an irregular triangle, their *bases* being fixed to the cricoid cartilage, and their *apices* directed upwards, forwards, and towards each other: they are somewhat twisted, and present an *external* convex and an *internal* concave edge, an *anterior* and a *posterior* surface.

The *bases* of these cartilages are made up of an articulating surface, which is concave, and opposed to the convex articular surface of the cricoid cartilage, in such a manner as to admit only of a lateral motion.

The *apices* are pointed and somewhat directed towards each other, and are occasionally furnished with a small isolated portion of cartilage, which has been termed by Soemmering, the cornula laryngis.

Their *anterior* surface is concave below, and convex above, owing to their twisted form; and is covered by mucous membrane, and the arytenoid gland. They give attachment to the vocal cords, and to the thyro arytenoidei muscles.

Their *posterior* surfaces are concave, and have the arytenoideus transversus muscle attached to them.

Their *external edge* is convex, and furnished with a tubercle, into which are inserted the crico arytenoidei laterales and postici muscles. It is these cartilages which, by their motions on the cricoid, enlarge or diminish the opening of the glottis.

The *epiglottis* is placed above the opening of the glottis, at the base of the tongue, to which it is connected, as well as with the os hyoides superiorly and anteriorly; below, with the thyroid cartilage, at its anterior fissure; and posteriorly, by the aryteno-epiglottidean ligaments, to the arytenoid cartilages. Its form is oval, and not unlike to the shape of the tongue, excepting that it is narrower at its base than in its centre. Its color is of a pale yellow: it is composed of a very elastic tissue, by which, under common circumstances, it is raised from the glottis. Its superior or lingual surface is convex from side to side, and concave from behind to before. It is covered by the mucous membrane of the mouth, which connects it with the tongue; and posteriorly, by the epiglottidean gland. Its laryngeal or under surface, is concave from side to side, and convex from before to behind—just the reverse to the lingual surface; and is covered by the mucous membrane of the larynx, which connects it, as has been before described, with the arytenoid cartilages.

The two surfaces of the epiglottis are furnished with a number of mucous follicles, and are perforated by minute foramina, for the passage of filaments of nerves.

Ligaments of the Larynx.

The five cartilages of the larynx which we have just described, are connected with each other by seventeen ligaments, namely: three broad, two round, four capsular, four vocal, and four to the epiglottis.

The three broad ligaments connect their cartilages at their anterior part.

The superior or *thyro hyoideal ligament,* commences from the lower and posterior edge of the os hyoides, and passes downwards, to be inserted into the whole length of the upper edge of the thyroid cartilage. Its anterior surface is covered by the sterno hyoidei, omo hyoidei and thyro hyoidei muscles: its posterior surface by mucous membrane, by the epiglottidean gland, and by the base of the epiglottis itself.

The middle or *crico thyroideal ligament,* passes from the whole length of the under edge of the thyroid to the upper edge of the cricoid cartilage, being stronger in the centre than it is laterally. It is covered anteriorly by the sterno hyoidei, sterno thyroidei, and crico thyroidei muscles; it is also perforated by a small branch of the superior thyroideal artery. Its posterior surface is covered by the mucous membrane of the larynx.

The third and lower broad or *crico-tracheal ligament,* proceeds from the lower edge of the cricoid cartilage, and proceeds to the upper edge of the first ring of the trachea. Its anterior surface is covered by the sterno hyoidei and sterno thyroidei muscles; and its posterior surface is lined by the mucous membrane common to the larynx and trachea.

The two *round ligaments,* are strong rounded cords, proceeding from the under surface of the extremities of the cornua of the os hyoides, to the upper surface of the superior cornua of the thyroid cartilage. In the substance of these ligaments there is generally found a small isolated rounded body, which is either cartilaginous or bony, depending upon the age of the subject.

The four *capsular ligaments,* are two which attach the thyroid to the cricoid, and two which form the crico arytenoidean articulations.

The arthrodial articulations, formed by the inferior cornua of the thyroid cartilage and articular faces on the sides of the cricoid, are strengthened by capsular ligaments, which are sometimes described as anterior and posterior fasciculi; but the fibres so completely surround the joints, as more properly to be called capsular.

The crico arytenoidean arthrodial articulations, are formed precisely in a similar manner to the above, and attach the bases of the arytenoid to the upper and back part of the cricoid cartilage. These, like all other arthrodial articulations, are furnished with muscles, which will hereafter be described with the particular motions they are destined to perform.

The four *thyro arytenoid ligaments*, or chordæ vocales, proceed, two on either side, from a projection upon the fore part of the base of each arytenoid cartilage, and pass forwards, converging towards those on the opposite side, to be inserted into the angle formed on the inner side of the thyroid cartilage, by the junction of its two lateral plates. The triangular space between the two lower cords is termed the *rima glottidis;* while the space between the upper and lower cord on the same side is called the *sacculus laryngis*, which is formed by the mucous membrane, as it is reflected from the one cord to the other. Externally the vocal cords and sacculi laryngis are bounded by the thyro arytenoidei muscles.

The four ligaments of the epiglottis, as they are termed, are little more than the reflections of mucous membrane which give attachment to this organ, above, to the os hyoides and tongue, in the centre forming what has been termed the frænum epiglottidis; below, to the thyroid cartilage; and behind, to the two arytenoid cartilages. The folds which pass to the arytenoid cartilages form, in fact, a part of the glottis.

Of the Muscles of the Larynx.

We have already described in the second volume, several muscles which act generally in raising or depressing the whole of this organ; but we have yet to describe those muscles which are proper to the larynx, and act upon the vocal cords. These may be divided into those which open the larynx and enlarge the rima glottidis, those which close the larynx and contract the rima glottidis, and those which regulate the tension of the vocal cords.

Two pair of muscles are destined to open the larynx, or separate the vocal cords from each other, namely: the crico arytenoidei postici, and the crico arytenoidei laterales.

The *m. crico arytenoidei postici,* are situated at the back part of the cricoid cartilage, and *arise* on either side of its posterior mesian line: the fibres pass upwards and outwards, to be *inserted* into the convex edge of the base of each of the arytenoid cartilages, at a point between the insertions of the arytenoideus muscle, which is behind, and of the arytenoidei laterales, which is anterior to it. The posterior surface of these muscles is covered by the mucous membrane of the pharynx: anteriorly they are in contact with the cricoid cartilage.

Use.—To draw the arytenoid cartilages outwards, and consequently to enlarge the rima glottidis.

The *m. crico arytenoidei laterales,* are situated at the sides of the cricoid cartilage, and *arise* from a space between, and anterior to the crico thyroid and crico arytenoidean articulations: the fibres pass obliquely upwards, backwards and inwards, to be *inserted* into the fore part of the convex edge of the base of the arytenoid cartilages, where its fibres become mingled with those of the last described muscles. Its outer surface is directed towards the thyroid cartilage, from which it is separated by cellular membrane: its inner surface is lined by the mucous membrane of the larynx.

Use.—To draw the arytenoid cartilages forwards and outwards, and consequently to enlarge the rima glottidis.

The combined action of these four muscles cancel each other as to their anterior and posterior direction, and admit only of the enlargement of the rima glottidis; but when the postici act alone, they render the vocal cords tense, at the same time that they enlarge the opening; while on the contrary, when the antici act alone, they relax the vocal cords at the same time they open the rima glottidis: so that the first pair of muscles contribute more particularly to the production of acute tones, while the second act in the production of grave tones.

The antagonists to these four muscles, and which close the rima glottidis, are three in number: the arytenoidei obliqui, and the arytenoideus transversus.

The *m. arytenoidei obliqui—arise* on either side from the inner concave edge of the bases of the arytenoid cartilages, and pass obliquely upwards and inwards, to be *inserted* into the apex of the opposite cartilage, from which they arise, crossing each other in their course. The posterior surface of these muscles is covered with the mucous membrane of the pharynx, and their anterior surface is in contact with the arytenoideus transversus muscle.

Use.—To draw the arytenoid cartilages towards each other, and consequently tend to close the glottis.

The *m. arytenoideus transversus,* is placed between the two arytenoid cartilages, and is covered by the two last described muscles; and is so closely connected with them, that the three have been frequently described as one muscle. It *arises* from the concave edge of the base of one arytenoid cartilage, and passes across to be *inserted* into the corresponding part of the opposite.

Use.—Similar to the two last, excepting that it closes the rima glottidis directly; while the two obliqui may act singly or together, and modify the inflections of the voice.

The pair of muscles which directly regulate the degree of tension of the vocal cords, are the crico thyroidei; while the thyro arytenoidei influence the intensity of sound, withdrawing the mucous membranes, so as to leave the vocal cords in the best possible state for their vibration.

The *m. crico thyroidei—arise* on either side of the fore part of the cricoid, ascend obliquely upwards and outwards, to be *inserted* into the lower edge of the sides of the thyroid cartilage. The anterior surface of these muscles is covered by the sterno thyroideus: posteriorly they are in contact with the crico thyroideal broad ligament.

Use.—To raise the cricoid towards the thyroid cartilage, and thus to direct the posterior part of the cricoid with the two arytenoid cartilages backwards, and consequently to stretch the vocal cords.

The *m. thyro arytenoidei—arise* from the middle and lower part of the inner surface of the lateral plates of the thyroid cartilage: they proceed backwards and slightly inwards, to be *inserted* into the anterior surface of the base of the arytenoid cartilage, immediately above the insertion of the crico arytenoidei laterales. Their outer surface is in contact with the thyroid cartilage: their inner surface is not only opposed, but is attached to the mucous membrane of the larynx, where it forms the sacculi laryngis, to which these muscles form an outer boundary.

Use.—When these muscles act alone, they must necessarily tend to open the glottis, and relax the vocal cords; but when they act in conjunction with the preceding pair, they are prevented from drawing the arytenoid cartilage forwards, and act only upon the mucous membrane of the sacculi laryngis, which they draw from the vocal cords, so as to prevent it from acting as a damper to their vibrations.

The *arteries* of the larynx are derived from the superior thyroideal branch of the external carotid, and from the inferior thyroideal branch of the subclavian artery.

The *veins* correspond with the course of the arteries.

The *nerves* are derived from the pneumogastric by two branches, a superior, and inferior or recurrent laryngeal, and from the two superior cervical ganglia of the sympathetic.

Its *absorbents* terminate in the deep jugular glands, situated in the course of the carotid sheaths.

The Thyroid Gland.

The thyroid gland is placed at the lower and anterior part of the larynx, and covers the first rings of the trachea. It is a glandular structure, of a reddish color, larger in the child and female than in the male adult, and its use is entirely unknown. Its color varies from a brownish red to a grey or yellow: its form is irregular, being composed of two oval lobes, thicker below than above; being concave posteriorly, where it rests upon the larynx, and convex anteriorly. The two lobes are connected by a middle transverse lobe, termed the isthmus of the thyroid gland, but which is occasionally wanting.

The thyroid gland is bounded in *front,* by the sterno thyroidei and sterno hyoidei muscles; on the *sides,* by the platysmi myoides, sterno cleido mastoidei, and omo hyoidei muscles; *posteriorly,* in the centre it rests upon the lower part of the cricoid cartilage, and upper two or three rings of the trachea; but the lateral lobes rise as high as the inferior cornua of the thyroid; it is also bounded posteriorly by the constrictor pharyngis inferior, and the crico thyroidei muscles: and its *edges* overlap the carotid sheaths, recurrent laryngeal nerves, and nervous filaments of the cervical ganglia, and on the left side the œsophagus.

It is *superiorly* bounded by the superior thyroideal arteries from the external carotid; and *inferiorly,* by the inferior thyroid branches from the subclavian arteries, as well as by large veins.

The thyroid gland has no proper capsule, being surrounded by cellular membrane only: it it composed of irregular lobes, divided into lobules: in these is formed an oily yellow fluid, which fills the areolæ of the proper tissue, there being no apparent proper cavity. Occasionally vesicles, containing a whitish milky fluid, are met with, and without any appearance of disease. No excretory duct has been discovered to this gland, or a sufficient number of absorbent vessels to give it the character of an absorbent gland. It is very plentifully supplied by the four large arteries which have already been described; but sometimes a variety occurs in the distribution of its vessels, in one large branch being given off from the arch of the aorta. The blood is returned not only by corresponding veins, but by some large branches, which pass downwards along the fore part of the trachea to terminate in the subclavian.

Its *nerves* are derived from the pneumo gastric and cervical ganglia.

Its *absorbents* pass to the jugular ganglia.

It sometimes happens that there is a variety in the position of this gland: it has been found so placed that its middle lobe passes behind the œsophagus, or between that tube and the trachea. Chronic enlargement, under such circumstances, might be productive of dangerous consequences. A narrow slip occasionally rises as high as the os hyoides; and in the infant, the lower part is always connected with the thymus gland.

The Trachea, or Wind-Pipe.

This tube commences from the lower part of the cricoid cartilage of the larynx, opposite to the fourth cervical vertebra, and extends to the lower part of the second dorsal or commencement of the third, where it terminates by dividing into the two bronchi. In this course in the cervical region, it is placed vertically; but when it reaches the chest, it takes a slight direction to the right. This tube is of a cylindrical form, being flattened posteriorly, and convex anteriorly. It is bounded *above*, by the larynx; *below*, by the bronchi; *anteriorly* and above, by the thyroid gland, by the inferior thyroideal veins, the sterno thyroidei and sterno hyoidei muscles; and lower down, by the thymus gland, left vena innominata, arteria innominata, and arch of the aorta; *posteriorly*, it is bounded by the vertebræ and by the œsophagus, which latter is rather to its left; and *laterally*, it is bounded by the carotid sheaths, and the recurrent laryngeal nerves; and just where it enters the chest, by the thoracic ducts.

At the termination of the trachea, opposite to the third dorsal vertebra, the *bronchi* commence resulting from the division of the trachea into a right and left tube, which pass to terminate in the lungs.

The *right bronchus* is larger, shorter, more horizontal, and somewhat anterior to the left: it enters the lung on a level with the fourth dorsal vertebra and base of the heart. Just before it enters, it is crossed anteriorly by the right pulmonary artery, and posteriorly by the vena azygos.

The *left bronchus* is smaller, longer, and passes more obliquely than the right. Before it enters the left lung, the arch of the aorta partly encircles it, and the left pulmonary artery passes anterior to it.

The bronchi continue to subdivide into minuter branches, to be distributed throughout the substance of the lungs in ultimate structures, which are so connected with the arterial and venous systems, and are so minute, as to render a knowledge of these terminations obscure and unsatisfactory.

Organization of the Trachea and Bronchi.

These tubes, destined for the circulation of air in respiration, are furnished with cartilaginous rings to maintain their open state and to prevent the collapsing of their larger branches, with an internal mucous surface, an external fibrous sheath, and an abundant glandular and follicular apparatus.

The cartilaginous rings of the trachea are from sixteen to twenty in number: they do not encircle the whole tube, but leave the posterior third of its circumference open. They are thicker at their anterior part than at their extremities, pass around the tube in an irregular manner, though generally parallel, one above the other, in an horizontal direction, and terminate at the membranous posterior third of the trachea, in slight pointed angular portions, directed upwards. Occasionally one will bifurcate at the anterior convex part, or terminate before it reaches the posterior membranous portion. Anteriorly these rings are covered by a fibrous membrane, which continues from the inferior surface of the cricoid cartilage to the bifurcations of the bronchi, and internally by the mucous membrane lining the trachea.

The first portion of the bronchi is furnished with cartilaginous rings similar to the trachea, but they soon decrease in thickness and extent, becoming small detached portions, which decrease until the tubes assume the appearance of arterial vessels: these ramify in all directions, until they terminate in what is termed the pulmonary lobule, which is said to result from the collection of several minute bronchial tubes, each of which terminates in a minute *cul de sac,* or air vesicle, and are held together by cellular membrane: thus constituting the proper parenchyma of the lung. Other physiologists state, that they terminate in cells belonging to the lung, independent of the bronchial tubes.

The internal mucous membrane of the trachea and bronchi is a continuation of the mucous lining of the larynx, and is supposed to extend to the ultimate divisions of the bronchi. It presents a slightly plicated appearance in a longitudinal direction, particularly where it lines the membranous portion of the trachea; it is there inclined to a reddish color, and is perforated by numerous follicles, which lubricate its surface with a viscid fluid.

External to this mucous lining, the trachea, where it is not occupied by the cartilaginous rings, is composed of a fibrous tissue formed of longitudinal and parallel fibres, the outer of which are redder than those which are most internal.

This forms the whole of the posterior third of the canal; and, as it were, encloses the rings in its anterior part, passing from one ring to another in minute bundles, more apparent at the extremities of the cartilages, where they have been considered to be of a muscular structure. On the outer surface of this membrane, posteriorly, are situated numerous reddish, oval, mucous follicles, named the glands or follicles of the trachea: these have excretory ducts, which open internally upon the mucous membrane.

There are numerous small, dark-colored glandular bodies placed upon the fore part of the trachea and bronchi, more particularly at the bifurcation of the trachea. They are termed the bronchial glands, and will be found also to enter into the substance of the lungs: they are not furnished with excretory ducts, although they have been supposed to pour out a peculiar fluid into the bronchi; but absorbent vessels may be traced to and from them, which afterwards terminate in the thoracic ducts.

The trachea is supplied with blood from the superior and inferior thyroideal arteries: its nerves are derived from the pneumo gastric and cervical ganglia.

The bronchi are supplied immediately from the aorta by two arteries named bronchial; their veins terminate in the vena azygos and superior intercostal; their nerves are given off from the pulmonary plexus.

Of the Lungs.

The lungs consist of the air-tubes and cells of the bronchi, of arteries, veins, absorbents, and nerves, held together by an extremely elastic tissue of cellular membrane, and enclosed within duplicatures of the pleuræ.

Their volume is always in proportion to that of the cavity of the thorax: for excepting the mediastina and their contents, the lungs completely fill this cavity, their volume increasing and diminishing with the motions of the thorax in the act of respiration.

Their figure also corresponds to the walls of the thorax, and may be described, therefore, as being conical: the base of the cone of each lung resting on the diaphragm, and the apex rising to the upper opening of the chest; besides which may be distinguished an anterior and posterior edge, an external and an internal surface.

The *anterior part* of each lung presents an acute edge, which is directed forwards and inwards, somewhat overlapping the pericardium; they are obliquely situated, passing downwards and forwards; and the left is notched to receive the apex of the heart. The anterior edge of one lung is separated from the other by the anterior mediastinum.

The *external surfaces* of the lungs are continued from the acute edge outwards and backwards to the posterior obtuse edges, presenting convex surfaces, corresponding to the concavity of the ribs; on these surfaces are observed the fissures which divide the lungs into separate lobes.

Each lung has one large fissure, which passes obliquely from behind to before, dividing the lungs unequally into a superior and anterior smaller and a posterior and inferior larger lobe. On the left side the apex of the heart is received into this fissure.

On the right side, the superior lobe is subdivided by a second fissure, which passes obliquely from the great fissure in a direction upwards and forwards, and thus divides the right lung into three lobes.

The *posterior edges* are thick and rounded, corresponding to the concavities formed by the articulations of the ribs with the vertebræ, and are separated from each other by the posterior mediastinum and its contents.

The *internal surfaces* of the lungs are irregularly concave, corresponding to the form of the heart, and in their centre the bronchi and pulmonary vessels enter, constituting the roots of the lungs; posterior to which these surfaces are separated from each other by the posterior mediastinum, and anteriorly by the pericardium, anterior mediastinum, and thymus gland.

The *bases* of the lungs are concave, resting upon the upper surface of the diaphragm; the base of the right, on account of the ascent of the diaphragm, is more concave and broader than the base of the left, which latter has, from this circumstance, as well as from the obliquity of the anterior mediastinum, a greater vertical dimension than the right lung, but on the whole is somewhat smaller.

The *apices* of the lungs occupy the upper part of the thorax, and are capable, during a forced inspiration, of rising through the upper opening of the chest into the cervical region.

Organization of the Lungs.

The parenchyma of the lungs is principally constituted of the termination of the bronchial tubes, which are held together by a highly elastic cellular membrane: besides which they contain the ramifications of the pulmonary arteries and veins, the bronchial arteries and veins, numerous absorbents, and the nerves of the pulmonary plexus; the whole being surrounded by the pleuræ pulmonales.

Having already described the ultimate divisions of the bronchi we may here remark, that there is a difference of opinion respecting the nature of the cells they form: some supposing that both the fibrous external, and the mucous internal membrane, are continued to their ultimate divisions, although in an extremely attenuated form; while other physiologists assert, that the mucous membrane ceases before the formation of the air-cells, around which the blood is consequently brought into closer contact with the inspired air than it would be with the intervention of the mucous membrane and its secretion. This theory is strengthened by the fact, that in bronchitis the air-tubes generally contain pus, while it is very rarely found in the air-cells: from this an opinion has been formed, that the air-cells belong to the structure of the lungs themselves, independent of the bronchial tubes.

The distribution of the pulmonary *arteries* is similar to that of the bronchial tubes, accompanying them from their larger branches to their minutest terminations.

The *veins* are supposed to commence from the ultimate capillary terminations of the arteries; but both the terminations of the arteries and the commencement of the veins are involved in that obscurity which such minute structures necessarily create, from our inability to view them even with our best microscopical instruments. Some assert that the arteries and veins anastomose upon the air-cells; others, that the artery terminates, and the vein begins by open mouths within them. The fact of their intimate connection is established by the course of injections; which, whether thrown in from the bronchi, artery, or vein, reciprocally fill each other.

The *bronchial arteries* distributed for the proper nourishment of the substance of the lungs are very various in their number and origin; they usually arise from the aorta, either by one or more branches; at other times, the right bronchial artery is derived from the first intercostal. When they enter the lungs they take the course of the bronchial tubes, accompanying them to their ultimate division. The *veins* which return the blood of these arteries do not correspond to them in their course; and a great variety of opinions exist relative to their termination, as some have described them as opening not only into the vena azygos, superior cava, subclavian, and intercostal veins, but also partly into the pulmonary veins, which would be a circumstance quite unlike what occurs in any other part of the body, as we should have the venous blood conveyed at once into the arterial circulation without having been purified by the contact of the air.

The *nerves* of the lungs are derived from the pulmonary plexus, formed by the pneumogastric and sympathetic nerves; which plexus, around the bronchi exterior to the lungs, produce numerous interlacements, and within their substance are indiscriminately distributed both to the bronchi and pulmonary vessels.

The *absorbents* are divided into a superficial and deep seated set: the superficial ramify beneath the pleuræ, and terminate in the bronchial glands, at the root of the lungs; the deep seated pass along the course of the veins, through the bronchial glands, and emerging from the chest, they terminate in the thoracic duct of their corresponding sides.

Physiology of the Larynx, Trachea, and Bronchi.

As these air-tubes are equally concerned in the production of the voice and the function of respiration, it will be necessary to consider their physiology under separate heads, and first—

Of the Physiology of the Voice.

The voice is produced in the larynx by its mechanical operation upon the air passing through it, much in the same manner as sounds are emitted from wind instruments; these sounds are variously modified, not only by the larynx itself, but in the direction they are made to take in their progress through the mouth and nasal passages, by the appropriate motions of the lips, lower jaw, tongue, pharynx, and fauces, as well as by the length of the trachea.

Speech is an acquired faculty, resulting from the appropriation of certain sounds emitted by the voice to express our ideas. The sounds constituting speech are infinitely numerous, as may be seen in the various languages and dialects of different nations.

The sounds of the voice, and their innumerable modifications, may be considered under three heads: natural, imitative, and musical sounds.

Natural sounds belong to all animals that have lungs; and may we not add the "voice of the cricket," though made by the motions of its wing and leg, the hum of bees, and various other sounds produced by insects.

The cry is the earliest natural sound, and establishes a remarkable instinctive intelligence between parent and offspring. Thus it readily expresses pain and fear, and will incite the almost defenceless hen to face the ferocious mastiff, in aid of her little ones in danger. The cry expresses the most simple wants, and natural passions; and this sort of language is found in most animals. In man it belongs to all ages and states: the infant and the aged, the savage and the civilized, the idiot and the person born deaf, all have the faculty of crying. It expresses many of our most vivid feelings: thus there is a cry of rage, of fear, of pleasure, and of pain.

Imitative sounds form the basis of all languages: hence speech is never acquired without the aid of the sense of hearing. Persons born deaf are also dumb, so far as the faculty of speech is concerned; for the simple reason—because the ear is unable to appreciate the sounds which are employed in language to express objects and ideas. For the same reason, a person who hears badly, is often inclined to speak high; or, having a false ear, has also a false voice: and those born deaf, who have been taught artificially to speak, have voices hoarse, dull, and with unequal inflections.

Young children begin by imitating the sounds they hear, in a very imperfect manner, being only capable of expressing those which are the most simple. In their early attempts they frequently substitute vowels, and sounds easy of expression, for names which are in any way complicated or harsh: so also in their first attempts to construct a sentence, their errors are all simplicity, and are regulated only by careful education, and the force of correct examples.

Nothing proves speech to be the result of imitation, regulated by civilized education, more than the existing varieties of language among different nations, as well as the peculiarity of dialect in different parts of the same country.

Rhetoricians have entertained various opinions respecting the origin of languages, which would be superfluous to consider here, as indeed they have been in general too speculative to have led to any useful conclusion.

The modifications of the voice are expressed in letters; and these, variously combined, form words, which are the signs of ideas, and the component parts of language.

The letters or alphabet are pronounced by varying the mode in which the voice is emitted: some letters, being quite simple, require hardly any action beyond the larynx itself: others require the motion of the tongue acting with its tip, middle, or base; others of one or both lips; while for the production of some, the air is made to pass the nasal cavities. Indeed, a clear pronunciation of any sound is not made when either from disease, or artificially, the nasal cavities are closed. The air, in its passage through the mouth only, appears to be arrested, and to impart a thickness to the voice; or, what is improperly termed, speaking through the nose.

The letters have been divided by grammarians into vowels and consonants; but, in a physiological point of view, we rather consider the mechanism by which they are pronounced. Thus the letters in all European languages, consist of those which are purely vocal, and are pronounced with very little effort: these are *a, e, i, o, u,* named vowels, and proceed entirely from the larynx, subjected however to numerous modifications, depending on the force with which they are uttered, producing long or short accents. So also we have, as enumerated by Majendie, *a* very open, as in *hall*, English; *â*, in *hâle*, French; *a*, *é*, *è* and *e* mute, French; *i*, *o*, open, Italian; *o*, *eu*, *u*, French; *u*, Italian. Other vocal letters are *b* and *p*, labial; *d* and *t*, dental; *l*, palatine; *g* and *k*, guttural; and *m* and *n*, nasal consonants. The other letters are *f* and *v*, *th*, English; *s* and *z*, *ch*, *j*, *r*, *h* and *x*, Spanish; *χ*, Greek; and are produced chiefly by the air being forced against the sides of the mouth, and directed by the tongue, either by its tip, middle or base: *v* and *f*, by the lower lip and upper teeth: *r*, in English, has a much softer sound than in French, where it is pronounced by a vibratory motion of the tongue against the roof of the mouth.

Words are compound sounds, formed by the combination of letters; and being arranged according to the rules of grammar, constitute a language.

Languages are more or less harmonious, in proportion to the number of vowels or simple tones which it contains: thus the Greek and Latin, among ancient languages; and among modern, the Russian, Italian and Spanish are more agreeable than those of teutonic origin, as the French, English, German, Dutch, Sweedish, Danish, &c.

Speech, considered as the means of communicating our thoughts, is the organ of our intellectual faculties: and herein constitutes the great superiority of man over the rest of the animated creation. He alone can express his feelings in appropriate language; can accumulate knowledge in the storehouse of his memory; can search for causes, and distinguish effects; and, above all, can judge and reflect upon the past, the present, and the future.

The third class of sounds produced by the voice is musical sounds, or vocal harmony.

Singing requires greater exertion than is used in speech, and the organs of voice are called into more varied as well as more powerful action. Thus the trachea is lengthened or shortened, by the stretching out, or drawing in of the neck; inspiration is accelerated, prolonged, or slackened; the larynx rises or descends; while the glottis is made to enlarge or contract, either by sudden and quick, or slow and gentle motions. Singing, therefore, consists of modulations of the voice; imitating, with varying rapidity, the different degrees of the harmonic scale; passing from grave to the acute, and from acute to the grave, in sounds which are appreciable by the ear, and regulated by the rules of harmony.

The powers of the human voice are very extensive, and vary remarkably at different ages and in different individuals. The characters of voices are distinguished by the names grave, acute, high, counter, tenor, base, falsetto, &c. We have already compared the voice to a musical instrument, in which the air is made to vibrate as in wind instruments: such, for instance, as the clarionet. In this a thin plate is made to vibrate, intercepting and allowing by turns the passage of a current of air, by which sounds are produced: this structure, termed the reed or anche, is fixed to a tube or body. If the plate is long, the sounds are grave; if short, acute, owing to the greater rapidity and strength of the vibrations in the short than in the long plate. The tube or body has no other influence on the sound produced, than upon its loudness or intensity: those which produce the loudest sounds are of a conical form, increasing in width towards their outer end: if the cone is inverted, a dull sound is produced; but if two equal cones are placed base to base, and adapted to a conical tube, as in the flageolet, the sound acquires fulness and power.

The larynx has been compared to different musical instruments by different physiologists. By Galen, to the flute; Dodart, to the horn; Ferrein, to the reed instrument: but it is considered at the present day to partake of the powers of both wind and stringed instruments, and capable of being regulated by vital action. The quantity as well as the force with which the air is propelled through the larynx, variously contributes to the loudness of the voice: these circumstances are regulated by the size and muscular power of the chest, the volume or size of the larynx, and the power of its proper muscles. In singing, the larynx acts the part of the reed, while the trachea answers to the tube: thus, in running up or down the whole scale of sounds, the neck and trachea are visibly shortened or stretched out.

Acute and grave sounds are produced by the motions of the rima glottidis, regulated by the tension of the vocal cords and their vibrations, as they are variously stretched by the muscles in the peculiar mechanism of the larynx. In grave sounds, Magendie observed in some experiments on dogs, that the air passed out through the whole length of the glottis, the ligaments vibrating in their whole extent. In acute sounds, only the posterior or arytenoid portion of the ligaments vibrated; and in proportion to the diminution of the opening of the glottis, so was the acuteness of the sound. The arytenoid muscles are those which principally produce these acute sounds, as is proved by the division of the superior laryngeal nerve which supplies them; and when divided, they establish a grave tone. It is therefore readily seen how much depends upon the consent of the muscular actions of the larynx, and the consent of the will, in exciting a due degree of tension and relaxation. A sound is readily produced in a larynx when blown into out of the body, and which will be similar to the voice of the animal to which it belonged, but different from that produced during life, in consequence of the want of that regulation which is produced from the tension of the vocal cords during life. Independent of these sounds, each individual has a particular tone of voice, which is readily detected by those who are accustomed to hear it. The same thing occurs among animals: in the same flock of sheep, each ewe and its own lamb are attracted by each other's bleating, and not by those of others.

The voices of women, children and eunuchs are more acute than those of men, from the comparative smallness of the larynx: it becomes weaker also during illness, from the loss of power in expiration.

The whisper is produced in a similar manner by a weakened action, in which the sound is not more audible than that produced by the passage of the air in forced respiration.

The larynx remains small until the age of puberty, when a remarkable change takes place: the cartilages of the larynx are then enlarged, and the voice sinks generally about an octave. This change is frequently a whole year before it is completed; during which time the voice is said to moult, or to be broken. Occasionally the voice, during this period, will be nearly lost for some weeks, or contract a disagreeable hoarseness: sometimes acute sounds are involuntarily produced instead of a grave one; and the power of singing, and producing appreciable sounds, is for the time wholly lost. This continues until the larynx is fully developed, the glottis is lengthened, and the pomum Adami projects forward. In the female, this change in the glottis at puberty is not apparent, and the voice remains acute.

In old age the voice is weakened from the loss of muscular power, and the want of the teeth: the voice is then much altered, and the pronunciation is frequently changed.

Considered as a musical instrument, the powers of the voice are greater, and infinitely more varied, than those of artificial instruments: it imitates all languages, and produces the most powerful expression of passion, particularly those of love and adoration, and in the highest intellectual pleasures.

We have yet to mention the deception practised by the art named ventriloquism, in which the voice appears to come from distant objects, and not from the actual speaker. This art has been named from the supposition that the voice came from the stomach, and that the ventriloquist had the power of directing it to any place at pleasure; but the fact is, that it is founded entirely on imitation. The ventriloquist, gifted with a genius for mimicry, observes the effects of various sounds produced at different distances; that they become feeble, less distinct, and that their expression changes: these he carefully imitates: deceiving the spectator, by directing his attention to the spot from whence he is to suppose the voice really issues. Thus the voice from behind a door, from a chimney, or down in a cellar, are such as are generally chosen for successful imitation; at the same time the ventriloquist chooses words which he can pronounce without moving his lips, rejecting as much as possible the labial consonants.

Function of Respiration.

The most obvious result in the process of respiration, is the change of venous into arterial blood: in which we have to observe, first, the alterations effected in the composition of the air respired; and, secondly, by the effects produced in the condition of the blood. For these purposes, respiration consists of an alternate succession of inspiration and expiration, during which the venous blood is exposed to inspired air in the air-cells of the lungs; and having also undergone the operation of the vital influence of these organs, is returned to the heart and general circulation of the body; while the air, which has undergone the action in the lungs, is expelled in expiration.

The great necessity for the constant continuation of this function, and its important purposes in the animal economy, is evinced by the fact, that the suspension of respiration, even for a few minutes, destroys life. It is not, however, so clearly obvious, wherein the changes produced in the blood, and the action of the atmospheric air in effecting these changes, consists; and there are still many phenomena in this important function which have not been satisfactorily explained.

In order to take a concise view of our present knowledge upon this interesting subject, I shall consider it under the following heads.

1.—The nature and properties of the atmospheric air.
2.—The volume of air respired.
3.—The changes effected in respired air.
4.—The changes produced in the blood.
5.—The connection of respiration with the production of animal heat.

1.—The atmospheric air is a compound gaseous body, surrounding the earth to about the height of forty-five miles, and revolving with it round the sun: according to the theory of Herchel, being confined to the earth by the force of the attraction of gravitation. It is composed of the proportion of 20 or 21 oxygen to 79 or 80 nitrogen in 100 parts by measure; while in the same quantity by weight, there are 23 parts of oxygen to 77 of nitrogen, which shows that the oxygen is rather heavier, and the nitrogen rather lighter than its own bulk of the compound: to these are added a variable quantity of carbonic acid, and more or less water in the state of vapour. According to some late experiments of Theodore Saussure, 10,000 parts of atmospheric air contain 4.9 of carbonic acid as a mean, 6.2 as a maximum, and 3.7 as a minimum.—(*An. de Ch. et Ph.* xxxviii. 411.)

Of these constituents, oxygen is the principal agent, and imparts the chief of the chemical properties possessed by the air. In the animal economy it is highly stimulating, and its presence is indispensable in the process of respiration. It must indeed not only be present, but in a certain quantity; for it appears that the more perfect animals cannot exist in an atmosphere which contains less than one tenth of its weight of oxygen: the molusca, however, have the power of depriving any given quantity of air of every particle of this gas. Although oxygen is necessary for the support of respiration, yet in a state of purity it is deleterious, as is proved by immersing animals in this gas. At first, no inconvenience is perceived; after an hour, their respiration becomes rapid, there is high excitement; then great debility comes on, and continues increasing until the animal dies.

Nitrogen gas is irrespirable, although it exerts no evident injurious effects either on the lungs or on the system at large; it however destroys life, by depriving the system of the presence of oxygen. Its use in the atmospheric air, and the exact purpose it performs in the animal economy, are not clearly known. Chemists have supposed that it performs the office of a diluent to neutralize the too stimulating effects of the oxygen gas; but how far this is really the case remains yet to be discovered.

Carbonic acid gas is like nitrogen, irrespirable; not only destroying life, by depriving the system of oxygen, but it excites a spasmodic action of the glottis, by which it closes so forcibly, as to prevent the entrance of the last portion into the lungs. It is constantly met with in the air of every part of the globe, whether from the lowest or the highest situations which have been hitherto attained.

The atmospheric air, consisting of the above named ingredients, is in all probability the only gaseous compound which is capable of being respired for any period, so as to answer all the purposes required in the animal economy. Its physical properties are, great elasticity and compressibility; whence arises a greater density in the air at the surface of plains or valleys, than on the summits of high mountains; the weight of the superincumbent atmosphere being greatest in the former situations.

We are not sensible of the weight of the atmosphere pressing on our bodies, because it is applied at all times, and in every direction, with a perfect equilibrium. There can be no doubt, however, of the fact, that a column of air, only one inch square, the height of the atmosphere, weighs about fourteen pounds: calculating that the surface of the body in a man of middle size is fifteen or sixteen square feet, it will follow that he sustains a weight of atmosphere equal to thirty-six thousand pounds. Many important purposes are answered by the pressure of the atmosphere: the fluids we now possess would all be converted into gasses, and even solids might become fluids, if the pressure of the air should be removed. The phenomena of venous circulation has been attributed to the pressure of the atmosphere by Dr. Curson and Dr. Barry; but their theory, of a partial vacuum being formed within the thorax, has many objections.

The weight or pressure of the atmosphere is variable, as its density is liable to alteration from different degrees of heat and other causes accompanying the changes of the weather. The variations of the weight of the air are indicated exactly by the barometer. At the temperature of 32° F., and the barometer at 29½, the weight of 61 cubic inches of air is twentry grains; the same volume of water, 15,444 grains: hence air is 770 times lighter than water.

Water combines readily with air, and this combination is rapidly increased by the aid of heat: cold, on the contrary, causes the water to separate from the combination, and is precipitated in the form of mist, fogs, rain, hail or snow.

The color of the air is blue, transmitting all the rays of light excepting the blue which it reflects: hence distant objects are tinted blue in proportion to their distance, when the air is clear.

2.—In order clearly to ascertain the chemical changes effected in the process of respiration, it is first necessary to estimate the volume of the air respired. Various observations and experiments have been made to ascertain this point; but as it depends upon the force employed in respiration, upon the habit of the individual, and still more upon the capacity of the chest and other varying circumstances, much difficulty has been experienced in forming any satisfactory conclusion. Three different degrees of respiration have been enumerated by physiologists: the ordinary, the forced, and the violent.

The ordinary respiration occurs during sleep, or in a state of bodily rest: in this degree the diaphragm is simply depressed, and the elevation of the thorax is almost insensible.

Forced respiration occurs during bodily exercise, or mental excitement, when the thorax is evidently raised, at the same time the diaphragm is depressed.

Violent respiration is occasioned by violent exercise, or imperfect action of the lungs: here all the muscular powers of respiration are called into action to dilate the thorax in every possible direction, as far as the physical disposition of this cavity will permit.

The number of respirations in a minute also varies in different individuals: Sir H. Davy respired twenty-six or twenty-seven times in a minute: Hales, twenty; and Dr. Thompson, nineteen: Menzies, fourteen; Majendie, fifteen: I respire eighteen. From hence the range is between fifteen and twenty-seven, and is usually accompanied by four pulsations of the heart to each respiration.

A still greater discrepancy occurs in the estimation of the volume of air which is breathed at each inspiration. Sir H. Davy estimates it at thirteen to seventeen cubic inches: Messrs. Allen and Pepys, at sixteen and a half: Mr. Kite, at seventeen: Mr. Abernethy, twelve; and Thompson and Menzies, at twenty.

The lungs of a stout man after death were found to contain 100 cubic inches, of which 31.58 were expelled by the resiliance of the lungs upon opening the thorax. Dr. Menzies observed the power which individuals possess of forcing an additional volume of seventy cubic inches in one inspiration: hence he estimates the range between an extreme expiration and an extreme inspiration, to exceed 200 cubic inches: Dr. Bostock, from several experiments performed on himself and others, at 160 or 170; to which he adds 120 as the residual air in the lungs, together making the natural volume 290.

Dr. Thompson thinks a fair mean would be, to estimate the ordinary quantity of air in the lungs at 280 cubic inches; forty of which enter, and go out at each respiration. Then calculating twenty inspirations to a minute, there would be 800 cubic inches respired in a minute, 4,800 in an hour, and 1,152,000 in twenty-four hours.

3.—We come now to enquire what changes are produced in the air, and what and how much of it is consumed in the process of respiration. The changes produced are an increase in the proportion of carbonic acid, and a variable loss of oxygen and nitrogen.

It was at first concluded from the able experiments of Allen and Pepys, that the quantity of oxygen lost, exactly equalled the quantity of carbonic acid produced; and hence, that the function of respiration consisted simply of the separation of carbon from the blood, and its union with oxygen in the lungs forming carbonic acid.

Subsequent experiments, however, have proved, that the consumption of oxygen is greater than is necessary for the formation of the carbonic acid gas expired; and that this varies from the proportion of one third of the volume consumed in the formation of the carbonic acid gas, to almost nothing. This variation has also been found to depend upon age, peculiarity of constitution, the species of animal employed; and it also varies in the same individual at different times. It is increased during exercise, digestion, and periodically during the twenty-four hours. Dr. Prout estimated these variations at 4.1 per cent. of oxygen inspired about noon, 3.3 per cent. towards eight o'clock in the evening; from which time to half-past three in the morning there is no change. Dr. Bostock has estimated the whole bulk of oxygen consumed in twenty-four hours, under ordinary circumstances, at 45,000 cubic inches; and the carbonic acid produced in the same period, at 40,000 cubic inches: Messrs. Allen and Pepys, at 39,534 cubic inches: a quantity equal to eleven ounces troy of solid carbon in twenty-four hours.

Subsequent experiments have also shown that a portion of nitrogen is occasionally lost, as well as oxygen; and in certain instances, a portion of nitrogen is generated. This last occurs in young animals; and is increased during the spring, and decreased during the winter. Sir H. Davy found, by repeated trials, that five cubic inches of nitrogen were consumed in a minute, making upwards of 7,200 grains in twenty-four hours. Allen and Pepys have endeavoured to prove that nitrogen was given out during respiration; while others, again, believe there is no alteration made in the quantity. It has been most indisputably proved by Spallanzani, that nitrogen is absorbed during respiration by reptiles generally: and Humboldt and Provençal have lately ascertained the same fact with regard to fishes.

Some doubt has been thrown on the fact of the production of carbonic acid in respiration, through the union of the carbon of the blood with the oxygen of the air. By some experiments performed by Dr. Edwards, he found that frogs and kittens immersed in pure hydrogen during eight hours, generated as much carbonic acid as when breathing atmospheric air during twenty-four hours: from which he concludes, that there is a possibility of carbonic acid being wholly generated in the lungs. The exact source, therefore, of the carbonic acid produced in the process of respiration, is still a matter of controversy. It is not clearly ascertained whether the venous blood absorbs oxygen in the lungs, or whether it merely gives off its superabundant carbon, which unites with oxygen, forming carbonic acid in the lungs themselves: thus making the essential difference of being formed within or without the blood-vessels. That both these processes may go on simultaneously, is also by others admitted; that is, that a portion of carbonic acid gass is given off, ready formed, from the blood, together with a portion of free carbon; or, as has been supposed, in the state of an oxyde or hydrate of carbon, which combines, with an additional quantity of oxygen in the lungs, the whole of the cabonic acid formed arising from these two sources. At the same time there is a portion of oxygen absorbed, which combines with the carbon in the blood, to generate the oxyde of carbon or the carbonic acid discharged from the blood in the lungs. The experiments of Dr. Edwards certainly prove the possibility of carbonic acid being secreted or eliminated in the lungs independent of the absorption of any oxygen from the air. Another experiment has been made, which seems to point out the possibility of oxygen being met with in the lungs in a state favorable to combination with substances in the circulation. The experiment consists in injecting phosphorus, dissolved in oil, into the veins of a dog; when the phosphorus will be expelled from the mouth and nostrils in the form of copious white fumes of phosphoric acid; which would seem to prove, that the phosphorus, in a state of infinite division, met with oxygen in the lungs, and there formed the phosphoric acid. If this is admitted in the one case, it is equally applicable to the other—in the formation of carbonic acid gass.

The real quantity of air is supposed neither to be lost nor increased during respiration; and that only a chemical change is produced. Sir H. Davy, however, considered that about 1-100th part of its bulk was consumed; and when air was repeatedly respired, the loss, according to him, became proportionally greater. It must therefore be confessed, that we are yet unable to draw any certain conclusion respecting the exact nature of the changes produced in the air by the process of respiration.

Connected with this part of the subject, it is right to mention, that the air is not the only gaseous respirable substance, although probably the only one which could be respired with impunity for any length of time. Of the different gasses, carburetted hydrogen, sulphuretted hydrogen, carbonic oxyde and nitrous gas, occasion immediate death by their specific action on the blood: hydrogen and nitrogen occasion death simply by depressing the system: of oxygen, carbonic acid, and probably acid and alkaline gasses in general, are wholly irrespirable, the glottis closing spasmodically from its mere contact only. When pure oxygen is breathed, about 100 per cent. of carbonic acid is produced; and a portion of nitrogen, equal to a similar portion of oxygen, lost.

It will be found that the function of the lungs is intimately connected with the functions of other organs: and particularly with the skin, in respect to the formation of carbonic acid. In hot climates, this is found to be more abundantly formed from the skin than in cold climates, and more abundantly from the skin of the negro than the European: and at the same time that it is greater in the skin, it is less in the lungs: hence the skin is capable of performing a vicarious office to the function of respiration.

An aqueous vapour is produced in respiration, which is supplied from the membranes of the mouth, fauces, larynx, trachea, and bronchi: its quantity has been variously estimated: Dr. Hales, at twenty ounces in twenty-four hours; Dr. Thompson, nineteen ounces; Mr. Abernethy, nine; Dr. Menzies, six. Majendie found this to be variously modified by changes in the state of the blood.

4.—The changes produced in the blood, resulting from respiration, are numerous, as may be seen from the following table.

	Venous Blood.	*Arterial Blood.*
Color	Brown red . . .	Vermillion red.
Odour	Weak	Strong.
Temperature . .	101-75° F. . . .	Near 104° F.
Capacity for caloric, water being 1000	852	839.
Specific gravity, water being 1000	1051	1049.
Coagulation . . .	Less rapid . . .	More rapid.
Serum	More abundant . .	Less abundant.

The change of color in the venous blood is evidently owing to its contact with oxygen, as may be proved, first, by depriving venous blood of contact with the air, when this change will not take place; but either out of the body, or by artificial inflation in the dead body, this change of color readily takes place: a bladder containing venous blood, and immersed in oxygen gass, will allow of this change, through its parieties; from whence we may learn, that venous blood may absorb oxygen through the parieties of the air-cells of the lungs; and still more readily the change is produced when blood is exposed to pure oxygen. How oxygen produces this change of color is not so easily ascertained: that it is through the agency of the iron in blood, Majendie considers to be likely; and states, that when the blood is deprived of its iron, the property of becoming scarlet, from contact with oxygen, is lost.

5.—The evolution of animal heat is a process which appears to be intimately connected with respiration, and the change of venous into arterial blood: but probably from the same reason that we are unable clearly to point out the exact process, by which oxygen is made to combine with carbon to be expired in the form of carbonic acid gass, we are as yet ignorant of the precise nature of the evolution of animal heat. The intimate connection of this process with the function of respiration, may be inferred:—First, from the size of the lungs in different animals being commensurate with the habitual temperature of their bodies. Thus, in all cold blooded animals, the respiratory organs are small, and therefore consume but a comparatively minute quantity of oxygen, and generate but little carbonic acid, their temperature being chiefly influenced by the change of seasons, and varying state of the *media* in which they exist. In warm blooded animals, on the contrary, where the respiratory organs are large, and the chemical changes are more abundant and complete, the temperature is almost uniform; and is highest in those which have the largest lungs in proportion to the size of their bodies, and consume the greatest proportion of oxygen. Secondly, from the connection of the temperature, and the state of respiration, in the same animal at different times. Thus when the circulation is slow or incomplete, as in various states of disease, and in malformation of the heart, the temperature is low, and the arterialization of the blood is imperfect. So also, when the body of an animal is immersed in a warm atmosphere, so as to require but little heat to be generated, the consumption of oxygen is unusually small, and the blood within the veins retains the arterial character. Thirdly, in young animals, the power of generating heat depends upon the power they possess of consuming oxygen; as may be seen by the experiments of Dr. Edwards, who has remarked that some young animals, as puppies and kittens, require so small a quantity of oxygen for their support, that they may be deprived of it altogether for twenty minutes without injury; but, at the same time, their temperature sinks rapidly by exposure to the air; while as they grow older, and are able to maintain their own temperature, this power of existing without the presence of oxygen ceases. These observations equally apply to birds, some of which are naked when hatched, and are, similar to puppies and kittens, capable of existing, deprived of oxygen, for a considerable time, depending principally on their parents for the support of their warmth; while others, as young partridges, who quit their shells fledged, and are thus enabled to maintain their own temperature, die from deprivation of oxygen as rapidly as adult birds.

These facts sufficiently prove the intimate connection which exists between respiration and the evolution of animal heat: it is, therefore, not improbable that sensible heat is given out in the combination of carbon with oxygen, the same as in every other instance of the union of oxygen with a combustible body; but then we are not warranted in considering this function as a mere chemical process, its connection with vital or nervous influence must be admitted; and herein may it not be considered to resemble the function of digestion, and other processes purely vital, in which a chemical influence is controled or modified by living or nervous influence.

Sir Astley Cooper found, when trying some experiments to ascertain the comparative heat of arterial and venous blood, that a thermometer, placed in the ventricle, rose when the animal was violently agitated, and fell when it was at rest, and the agitation subsided,—which would strengthen the supposition that animal heat is greatly promoted by the direct action of nervous influence.

Facts of such importance, that they cannot be wholly rejected, have been adduced, both by those physiologists who consider the evolution of animal heat as a mere chemical process, and by those who ascribe it solely to the influence of the nervous system.

The fact, that carbonic acid gas is generated, and apparently in proportion to the quantity of oxygen consumed, can scarcely be doubted; and that the process of respiration is the chief source of the consumption of oxygen, as well as the exit of carbonic acid gas.

According to the theory of Crawford, heat depends upon the different capacity for caloric between arterial and venous blood, being in the ratio of 104,5 to 100, hence forming a latent principle in arterial blood, to be given out as it flows through the system, and changes to venous blood. Mr. Brodie ascertained, from his experiments, that artificial respiration may be maintained in a decapitated rabbit, and all the changes of venous to arterial blood effected; the same deterioration of the air takes place, without the least increase, but rather with a diminution of temperature, the animal being cooler, by one degree, than another rabbit in which no such arterial change was effected,—from whence he infers that animal heat is independent of respiration, and must depend upon nervous influence altogether.

Another experiment has been tried, which proves that arterial blood may, by means of galvanism, be made to assume the venous hue, and at the same time to give out heat. The trial was made with the blood of a rabbit, immediately upon being drawn; upon applying the galvanic influence, an evolution of heat, amounting to 2° or 3°, took place: no rise of temperature could be produced in venous blood by the same means. From the whole it must be confessed, that this department of physiology requires more research, and a careful repetition of many of those experiments upon which the theories of Crawford, and others, have been supported; and particularly with due regard to the temperature of the air inflated, and the natural temperature of the animals employed. The great uniformity in the heat of the blood, in all ages and in all climates, is a circumstance no doubt connected with many of the phenomena yet unexplained. Mr. Brodie's and Dr. Davy's experiments have certainly shewn, that Crawford's theory of the production of animal heat is not, as he supposed, the mere chemical result of the difference of capacity for caloric on one hand, between carbonic acid and oxygen, and on the other, between arterial and venous blood. Still, when the nervous influence of the brain is in full action, who can say such changes may not actually be carried on, or if the evolutions of animal heat does not wholly depend upon a reciprocal action between the nerves and the arteries, which the decapitation annihilates. In local diseases there is frequently an increased local temperature, greater than the mere increase of circulation in the part is able to explain; the common occurrence of such increased temperature in the hand, from exposure to cold, independent of disease, can hardly be accounted for, unless we admit other sources of animal heat, independent of the pulmonary circulation, but of which the *modus operandi* has not been discovered.

Connected with the evolution of animal heat, there is a circumstance attending it that is particularly worthy of notice in the progress of experiments: which is, that sensible heat is variously experienced in certain states of mental agitation, and the progress of febrile affections; the skin feeling cold to the individual, while it is actually hotter to the touch of another person, and *vice versa*. Are these states realities or a mere deception, depending on disease? If a reality, may it not depend upon a peculiar vital action, rendering the latent caloric sensible, previous to its being given out in a free form on the surface of the body.

Practical Remarks.

There are numerous diseases and accidents incident to the larynx and trachea, which render a surgical operation necessary for the formation of an opening in the air-tube, for the admission of the air in respiration. The technical term given to this operation was formerly bronchotomy, in whatever part of the tube the opening was made; but of late years the term laryngotomy and tracheotomy has been adopted, to designate the precise point at which the operation is performed.

The causes which render these openings necessary are those which form obstructions to the free passage of the air in respiration: such as thickening of the mucous membrane of the larynx and trachea, or submucous tissue in the progress of acute or chronic inflammation; the depositions of adventitious membranes, as in croup; pressure from external tumours; enlargement of the tonsils or the tongue; the pressure of extraneous bodies passing through the glottis, or sticking in the œsophagus; gun-shot wounds; and wounds from arrows or other pointed instruments penetrating the air-tube: each of these circumstances, by obstructing the respiration, occasion such urgent symptoms, that immediate steps must be taken to prevent suffocation.

It will be readily seen, that although the object is the same in each of these cases,—to establish a free access of air to the lungs,—the causes are so different, that they require considerable variation in the means which are necessary to be adopted. For instance, when, from idiopathic causes, the object is not only to relieve the patient from the immediate danger of suffocation, but to establish a passage during the process of cure; and when, from the presence of a foreign body in the trachea, such an opening must be made as will be necessary to effect its abstraction; but still greater differences may be required in obstructions arising from either tumour or foreign bodies lodged in the œsophagus, so as to press upon the larynx or trachea.

When the object is merely to establish a free passage of air, it may be attained by the introduction of a canula into the larynx or trachea; which instrument, by exactly fitting the opening which it makes, has the advantage of preventing any hæmorrhage from entering the bronchi. Various modes of performing this operation are recommended: by some, a canula and trochar are at once thrust into the part; but this is objectionable, on account of the force which is required in penetrating the skin and parts underneath, and from the danger of passing the trochar so far as to wound the posterior parts of the wind-pipe. In tracheotomy, an incision should therefore always be first made through the common integuments and cellular membrane, to the extent of from two to three inches, extending from half an inch above the centre of the sternum, to a little above the cricoid cartilage in the central line of the neck. The skin should then be drawn aside with bent probes; and if any vessel appears exposed to the knife, it should be drawn aside in a similar manner. The incision is then to be continued between the sterno hyoidei muscles to the fascia which covers the trachea, within which it will be seen to slide up and down, in proportion to the violence of the efforts in respiration. A portion of this fascia should be removed, either with a knife or a pair of scissors, to secure the correspondence of the opening in the trachea to the external incision, and to facilitate the introduction of the canula. The trachea will now be in view; and when there is an irregular distribution of the blood-vessels, the large thyroid vein may here interfere, and must be avoided. All hæmorrhage, when time permits, should now be carefully secured; and the surgeon should wait until even that from the sides of the wound is stopped, in order, as much as possible, to prevent the passage of any blood into the trachea, which would accelerate suffocation. It is generally recommended, that the head should be thrown as far back as possible, in order to extend the anterior part of the neck; but this must be done with caution; for when the parts about the larynx are thickened, this bending of the neck may so increase the obstruction, as in itself to cause suffocation before the operation is completed. The canula and trochar may now be introduced, either between the rings of the trachea, or a small portion of one of the rings may be cut out, so as nicely to fit the introduction of the canula: to do this, a small slit should be made in the cartilage of the trachea, so as to permit the introduction of a hook or forceps to lay hold on the part to be removed. When the membrane lining the trachea is first punctured, or canula introduced, it generally occasions great uneasiness; which, however, quickly subsides. The canula is secured by a tape around the neck, and a piece of fine muslin should be placed over its orifice, to prevent the entrance of foreign bodies.

When this operation is performed for the extraction of foreign bodies in the trachea, a portion of the trachea may either be cut out, or a longitudinal slit should be made in it, which permits of its being again closed immediately after the foreign body is extracted. Certain occurrences are of great moment in the progress of these accidents, which should be carefully attended to by the surgeon: for instance, a child will swallow a bead, a bean, or other substance, which, sliding into the trachea, causes sudden and distressing symptoms as long as the body is forced against the highly sensitive membrane lining the larynx and upper part of the trachea; but if it sinks lower down, where the membrane of the trachea is not so sensitive, all the unpleasant symptoms cease, and the child is suddenly relieved, and is frequently supposed merely to have had a fit, or an attack of the croup. A judicious surgeon will not rest satisfied with these fallacious appearances, but will examine carefully the state of the breathing, with a stetheascope or by other means; when, if a foreign body be present, it will generally be detected, and an operation should be at once performed, to prevent the too frequent occurrence of suffocation, from the body being forced against the rima glottidis, so as to close its aperture. The opening should be made at about the third or fourth cartilaginous ring of the trachea, and not too near to the larynx. If the foreign body is below the opening, it will be forced out in expiration; and if above, it may be seized with a bent forceps. The advantage of making the opening at a little distance from the cricoid cartilage, is to avoid the inflammation which is liable to spread into the more sensitive membrane which lines the internal surface of the larynx, and the upper portion of the trachea. In certain instances, symptoms are so urgent, that the surgeon has no time to resort to the steps recommended above: in such cases it is advisable as quick as possible to pass a trochar and canula to restore respiration, and then proceed to the steps which may be necessary to remove the foreign body.

The operation for laryngotomy is resorted to when the foreign body or obstruction to respiration, is situated in or above the rima glottidis. Occasionally very smooth or polished bodies may be lodged in the ventricles of the larynx, without producing any immediate urgent symptoms, beyond violent coughing; and will remain impacted in this situation for a considerable time, until eventually abscesses form. Bones of fish, and angular or pointed bodies, on the contrary, get entangled in the rima glottidis, occasioning spasms and other urgent symptoms, quickly followed by suffocation. The patient, unable to speak, generally in these cases points with the finger to the exact point where the body is lodged.

The opening in laryngotomy is most conveniently made in the small triangular space between the thyroid and cricoid cartilages. A small incision, of about an inch in extent, is first made through the common integuments, directly over the part intended to be opened; the incision is then extended between the sterno hyoidei, sterno thyroidei and crico thyroidei muscles, down to the larynx: which being done, a bronchotomy trochar is passed into the larynx, or a portion of the crico thyroidean ligament may be taken out. Care should be taken to prevent the canula from being driven forcibly out by the irritation it occasions at its first introduction: this irritation soon subsides, and the canula may be worn for an indefinite period, unless its presence occasions such a degree of inflammation, that it can no longer be borne.

The most distressing symptoms in the after treatment arises from the continual accumulation of mucus, which is liable to block up the canula: an assistant must therefore attend to remove the mucus with a probe. Sometimes it will be necessary to use a syringe; and advantages has been gained by having two trochars, one to slide into the other, which facilitates the removal of the mucus as often as it may be necessary.

The time that the canula should be worn, and the wound kept open, depends upon the continuance of the obstructed respiration: in general, three weeks or a month, will effect all that may be required; but when protracted beyond that period, the result is generally observed to be unfavorable. There are, however, instances on record, where the canula has been worn for many months. This, as well as every other circumstance attending the after treatment, must depend upon a variety of casualties incident to each individual case. When it is determined to close the wound, it may be easily effected with strips of adhesive plaister to draw its edges together. When abscesses form in the neighbourhood of the larynx and trachea, they occasionally cause pressure on those parts, and require to be opened: when very deep, they may be successfully treated by openings near the part, to which the matter will very soon extend and make an exit. When behind the cricoid cartilage an operation is sometimes required: an incision must be made down to the thyroid cartilage, which must be taken as a guide; then proceeding backwards, the abscess may be felt and opened.

In cases of obstructed respiration from pressure, caused by foreign bodies lodged within the œsophagus, it seldom if ever happens, that if the body is lodged below the larynx, that it may not be pushed into the stomach, which should therefore be attempted in every instance before resorting to the operation of bronchotomy. Cases are on record where this has been effected after the operation of bronchotomy had been performed, and there was no reason why it should not have heen done in the first instance, and the patient saved from the pain of a formidable operation.

Practical remarks connected with the lungs and viscera contained within the thorax, have already been mentioned when speaking of that cavity.—*Vide Vol. II. p.* 172.

Of the Blood.

The description of the blood might very properly follow that of the heart, and vessels, which are formed for its circulation throughout the body; but as the subject is so intimately connected with the function of respiration, it seems more proper to treat of it here, as it may indeed be considered in some measure as a continuation of the physiology of respiration.

The blood forms an intimate part of all living animals; and probably to its influence, in conjunction with that of the nerves, we may refer the most essential seat of vitality.

The use or function of the blood is as various as the different structures of the human body; in each of which it appears to be destined to a peculiar action. Speaking generally it may be said to be a fluid circulating throughout the body in three states, and in three sets or systems of vessels, which have each peculiar characters.

In the first set, the blood is distributed through arteries to every part of the body, in appropriate quantities necessary to the function of each: these arteries may be termed the vessels of distribution.

In the second set, the blood enters a series of infinitely minute capillary vessels; in which, being acted upon, by the vital influence of the nerves, it is appropriated in the growth, secretion, or excretion of each individual organ: these may therefore be named vessels of appropriation.

The third class or set of vessels are called the veins: these return what remains of the blood, after it has been distributed and partly appropriated, from every part of the body, in order to be again subjected to the process of respiration, and to be replenished by receiving the product of assimilation: these may be termed the vessels of renovation.

In a physiological point of view, the uses of the blood may be therefore comprehended under the three terms of distribution, appropriation, and renovation: functions by which every part of the body is formed, maintained, and renovated.

The blood differs in its properties in the arteries and in the veins, and probably a still greater difference exists in their connecting or capillary systems. [For the general differences between arterial and venous blood, *vide* p. 220.] It is not only the physical properties marking the distinction between venous and arterial blood which render the differences of the two fluids important. In a physiological and pathological point of view, it should be borne in mind, that the red arterial blood is circulating, fitted and destined for all the offices of life; while the modena red or venous blood is flowing towards the heart and lungs, to be renovated for future circulation: hence it is that the loss of venous is not productive of the same injury as that of arterial blood, and the surgeon has not therefore the same dread of fatal consequences: and moreover it should be remembered, that under particular circumstances, even whilst contained in the arteries, the blood may undergo a change of color and qualities, so as to put on all the appearances of venous blood: thus any cause which greatly retards its flow, may produce such an effect: and hence it is, that in operations for such diseases as diminish or interrupt the natural course of the blood, the surgeon will be induced most carefully to secure all bleeding vessels, although the blood may flow as continuously as if from a vein.

We have hitherto spoken of the blood as a part of the living system; but as it possesses properties very different when separated from the circulation, it will now be necessary to examine the changes which it undergoes out of the body more particularly: and first let us consider it as a homogeneous fluid, or rather as it so appears when flowing from the living body.

The *quantity* of blood, compared to the solids of the body, has been estimated by Sir Astley Cooper at an ounce to a pound: this was the result of many experiments made upon dogs; and, as these are almost the only recorded researches upon this subject, we are perhaps justified in drawing our conclusions from them; but, at the same time, are not to take it for granted that the same proportions exist between the blood and solids of the human species.

The temperature of the blood in a healthy state when flowing from a vein, is estimated to be from 98 to 100° of Farenheit's thermometer; which is much more than the mean degree of the atmospheric heat, though less than the greatest. It is supposed by some, while it is denied by others, that the blood in the living body undergoes a change of temperature, from the influence of the atmosphere; but I believe the difference of opinion originates from one party examining the heat of the body, supposing its temperature to depend entirely upon the blood, while the other examined the heat of the blood itself. It seems, however, now to be generally considered, that the blood is incapable of undergoing any change of temperature while circulating through a living animal: this may be proved by the following experiment:—If you immerse a thermometer in blood flowing from a vein, the heat of that blood will be the same, whether the person has been exposed to the influence of a high or low temperature: but, on the other hand, if a thermometer be placed in the mouth or anus of a person exposed to a great degree of cold, it has been found not to rise above 76° of Farenheit's thermometer: shewing that the heat of the body depends upon other circumstances than that of the blood.

It has also been maintained, that the heat of the blood varies in different parts of the body; and that the arterial, is two degrees hotter than the venous. Sir Astley Cooper has however, in my opinion, by experiment proved the fallacy of this supposition: he passed a thermometer, made for the purpose, into the jugular vein and carotid artery of a sheep, when they both immediately rose to 104°; remaining, however only at that high temperature as long as the animal was agitated by pain, on the cessation of which they both fell to 102°: proving that in this animal at any rate the arterial and venous blood are of the same temperature; and perhaps proving also, that something between 98°, the computed temperature of the blood when flowing from the living body, and 102° when within it, would be the proper estimate of the blood's heat:—and further, this experiment shews how much the sensible heat of the blood depends upon nervous influence.

The *specific gravity* of blood, as compared to water, varies considerably, but is estimated at 1045, varying to 1054, water being 1000: but in treating of this subject, experimentalists have not mentioned whether they were speaking of arterial or venous blood; for Dr. Davy has shewn, that there is a difference in their specific weight: the former being 1049, and the latter 1051.

It is remarked by physiologists, that the higher the degree of vitality of the animal, the greater the specific gravity of the blood; and this seems to hold good throughout the animal kingdom.

Such are the views which may be taken of the blood under the consideration of it as a homogeneous fluid; in which state it remains, only while circulating in the body;

for soon after its removal from the circulating system, it separates into a solid and a fluid portion: constituting what is termed the coagulation of the blood.

This spontaneous separation leads at once, therefore, to the further consideration of these two parts: of the fluid, which is termed the *serum;* and of the solid mass, which is named the *crassamentum.*

The proportions which these parts bear to each other in the blood of a healthy person, is estimated at about 3-4ths fluid or serum, to 1-4th solid or crassamentum; but there is a considerable variation in these proportions, depending upon the health and vigour of the person from whom the blood is drawn.

The blood begins to coagulate in about four minutes after it has been abstracted; and in about eight, it would appear as if coagulation were complete: this, however, will be found not to be the case; for if the supernatant serum be poured off the coagulum, a further separation will occur, and serum continue to ooze from the crassamentum for ten or twelve hours.

On Coagulation.

This spontaneous separation of the blood when abstracted from its vessels, takes place equally in the air or in a vacuum, during heat or cold, when at rest or in motion, and even where the blood becomes extravasated in the living textures of the body. From the insufficiency of each of these physical conditions to explain the phenomenon of coagulation, John Hunter, and, since his time, other physiologists, have been induced to attribute this change to the loss of the vitality of the blood.

The cause of coagulation by some has been attributed to the change of *temperature* when drawn from the living body: but in answer to this, it has been found to coagulate when extravasated in the living textures, and consequently undergoing no change of temperature. Mr. Hunter found that the exposure of blood, immediately upon being drawn, to a temperature which caused it to freeze, did not, on its being thawed, prevent its coagulation.

The heat of 120° quickens the coagulation: and it is even probable, if the temperature of the living body could be raised to that degree, that the blood would be coagulated. *Admission of air*, from some experiments of Hewson, appeared to quicken the blood's coagulation in some degree; but it cannot, nevertheless, be supposed to depend upon such admission, as the blood coagulates, as has been before mentioned, when extravasated in the living body.

It has been thought that *motion* might prevent coagulation, and that rest might therefore be assigned as the cause producing it: but by some experiments made by Sir Astley Cooper, it is proved that rest at any rate is not to be considered as the principal cause. He placed two ligatures on the jugular vein of an animal, so as to insulate a portion of blood from the circulation; and under these circumstances the blood did not coagulate for three hours: but on a similar portion of vein being detached from the surrounding cellular membrane, so as to cut off its source of nourishment, and thus destroy its vitality, coagulation took place in ten minutes. From this experiment, Sir Astley Cooper infers that the vessel itself imparts an influence to the blood, which maintains its fluid state.

This supposition is further strengthened by the fact, that in mere dilitation of an artery, before the internal coat has given way, the blood in the dilated part of the vessel does not coagulate; but immediately that the inner coat gives way, a coagulum is formed.

These circumstances may all be considered as tending to prevent coagulation of the blood within the body; but few physiologists have yet directed their attention to the inherent tendency of the blood to coagulate, or the causes which promote its coagulation.

Sir Astley Cooper used however, in his lectures at Guy's Hospital, to ask, as a physiological query, if the property of coagulation in the blood, might not be derived from the function of digestion. "The gastric juice," said he, "causes the coagulation of milk, and all other nutritious fluids, previous to their assimilation; and in this state they are presented to the absorbent vessels of the villi of the intestines, and conveyed to the blood; imparting, probably, to it, the principle of coagulation." And he used further, in strength of this hypothesis, to remark: that in impaired constitutions, in which the powers of assimilation were weakened, the coagulation, both of the nutritious parts of the food, and of the blood, was similarly interfered with.

Of the Serum.

The serum, as has been before mentioned, bears a proportion, in healthy blood, of 3-4ths to 1-4th of crassamentum: it seems to be the solvent of all the other parts. It is of a yellowish-green or straw color, semitransparent, and fluid in the common temperature of the atmosphere; but at the temperature of 160° of F. it becomes solid, excepting a small portion which still remains fluid, and is termed the *serosity*. The mineral acids and alcohol will also produce coagulation of the serum: the former by its affinity for the salts, and the latter for the water contained within the serum. Other substances will also coagulate it, and none more readily than the acetate of lead.

The specific gravity of the serum is 1.030. It reddens turmeric, and changes the blue of violets to green—a power derived from its alkaline properties.

When coagulated by heat, or any other cause, it forms a firm yellowish-green mass, resembling both in appearance and properties, the white of an egg, but differs from it in being combined with water, and not being contained in a membrane; but as the principle of coagulation is owing to the same substance in each, it has been called *albumen*.

The *albumen* forms about 1-10th of the weight of the serum; has no power of spontaneous coagulation in consequence, as it is supposed, of the presence of alkaline substances, which, if added to blood when first drawn, will prevent its coagulating. When coagulation of the albumen is produced either by heat or acids, the whole will not be converted into a solid mass, as a small quantity of soda in solution will ooze from the coagulum, which is termed the *serosity;* which contains the alkaline substance in so concentrated a form as to resist the action of heat and chemical agents, and in time it is found to re-dissolve a part of the coagulum. When the serum is first separated from the blood, it will be sometimes found, clouded by white globules floating in it: this is most likely to occur if the blood be drawn a short time after a meal, and seems to arise from the chyle not being yet completely mixed with it. It is not however invariably seen, although a person may be bled two or three hours after eating; but it seems to depend upon some diseased condition. Dr. Crawford, formerly one of the physicians of St. Thomas's Hospital, observed this appearance in the blood of a patient of his, labouring under a pulmonary complaint: and Dr. Currie, of Liverpool, saw the same appearance in the serum taken from a person who was supposed to be the subject of inflammation of the spleen.

Mr. Brand has given the following analysis of the human serum:—100 parts containing—

Water	90
Albumen	8
Carbonate of soda . .	1
Muriate of soda . . .	1
	100

Analysis according to Dr. Marcet:—

Water	900.00
Albumen	86.80
Muriates of potash and soda . .	6.60
Muco extractive matter	4.00
Subcarbonate of soda	1.65
Sulphate of potash	0.35
Earthy phosphates	0.60
	1000.00

Some have supposed that there is also a small quantity of sulphur in the serum, and have considered it as a demonstration of the fact, that if serum be heated, and silver put into it, it becomes immediately stained.

One of the demonstrable uses of serum seems to be, for its circulation through the vessels of the transparent parts of the body: as the cornea, in which situation, if the red particles were admitted, vision would be destroyed, or at least impaired.

Of the Crassamentum.

This clot of blood is separable into two portions,—the *fibrin*, constituting 36 parts, and the *red particles* 64 out of 100; the former is that which gives the peculiar and principal properties to the blood; and to the latter is attributed the color of the fluid.

The *fibrin* may be perhaps considered as the most important part of the blood; it is found in all animals, even in those in whose blood no red particles can be detected; it forms the solid structures of the body; and is, in fact, the main constituent of the muscular system. Its specific gravity is somewhat less than that of the serum, hence it floats; but the difference is so inconsiderable it might almost be said to be in an equilibrium. It is obtained by washing the crassamentum, and then separating it from the red particles, when it appears as a tough, white, fibrous, and somewhat elastic body. From the interlacements of its fibres it has been regarded, by some physiologists, as possessing an organized nature; but the arrangement of its parts are neither sufficiently regular nor defined to admit of this supposition. The fibrin separates from the serum spontaneously; but the question is not yet settled, whether its coagulation depends upon something lost or something acquired; the probability lies, as I have before remarked, with the former, but the proofs are only negative.

The grand distinction between the fibrin and albumen is, the alkaline nature of the latter, which forms the great barrier to its self-coagulation; a condition which we might premise as necessary to a body whose action was destined to be that of a solvent or menstruum.

The red particles become entangled in the crassamentum, simply owing to the common principle of attraction: for all bodies which have a tendency to become solid have a power of separating extraneous bodies from a fluid; it is from this principle that sugar is clarified by blood, and coffee by the white of egg.

Whenever the coagulation of the blood is imperfect, and takes place but slowly, the red particles sink to the bottom of the coagulum, and then the fibrin remains above uncolored by them, and forms what is termed the buffy coat.

Fibrin is not like serum, a compound mass, it is a purely animal proximate principle, or, in other words, a substance which can only be resolved into its elementary constituents.

Fibrin is observed to be more abundant in carnivorous, and albumen in herbivorous animals.

The physical and chemical differences of these two substances, independent of external qualities, are—

1st.—*Fibrin* is spontaneously coagulable—*albumen* is not.

2nd.—*Fibrin* is neither miscible nor soluble in water, whether hot or cold—*albumen* is insoluble in the former, but miscible in the latter.

3rd.—*Fibrin* is acted upon by nitric acid, producing that peculiar substance termed adipocere—*albumen* is converted into gelatine by the same acid.

Their elementary constituents are as follow:—

		Carbon.	*Nitrogen.*	*Oxygen.*	*Hydrogen.*
100 pts.	Fibrin	53	19	19	7
	Albumen.	52	15	23	7

Thus it will be seen that these bodies which are so physically different, approach very near to each other in elementary composition. Fibrin contains more nitrogen than albumen, but the latter contains more oxygen than the former.

It is this spontaneous coagulable part of the blood, the fibrin, which is not only of such importance in forming the solids of the body, but also in repairing wounds, or preventing death from hæmorrhage, which would otherwise unavoidably terminate fatally upon the opening of the smallest blood-vessel; and in forming a barrier to the passage of matter and foreign bodies into the interior of the most important cavities of the body.

The *red particles*, which have already been described as forming 64 parts of a 100 of crassamentum of the human blood, are not found in the blood of all animals, nor indeed in every part of the body of the same animal: hence it may be presumed, that they do not form so important a part of the blood as the other constituents. They are with great difficulty procured free from other substances. Vauquelin recommends the digestion of the crassamentum drained of serum, in dilute sulphuric acid, at a temperature of 160°; the liquid is to be filtered while hot; to be evaporated to half its bulk, and saturated with ammonia; and the coloring matter which falls, washed and dried. Much speculation has existed as to their figure, bulk, &c., as may be supposed must necessarily be the case, when they are estimated to be only 1-4500th of an inch in diamater. Dr. Young describes them as being circular, flattened, transparent disks, with a dark spot in their centre: others consider them spherical, and only appear flattened from the same reason that a small globule seen under an intense magnifying power, will give rise to a similar illusion; or, as a large globe seen by the naked eye at a vast distance. These particles are said to consist of a nucleus and an envelope, in which resides the coloring matter. They are more numerous in arterial than venous blood, and are more abundant in animals in proportion as the ordinary temperature of their body is elevated. When calcined, and digested in muriatic acid, they yield very evident traces of iron: it was formerly supposed this iron was the product of calcination; but it is stated by Prevost and Dumas, that, by the usual tests, the metal may be detected in the pure blood, after a stream of chlorine gas has been passed through it.

It has been stated that the iron forms by weight 1-1000th part of the whole crassamentum; and the total quantity of the metal contained in the blood of an ordinary sized individual, is estimated at about three ounces; but whence the iron proceeds, is beyond the science of philosophy to detect.

The coloring matter, according to Brand, when incinerated, affords a residue consisting of—

Oxide of iron	50 . 0
Subphosphate of iron	7 . 5
Phosphate of lime with magnesia	6 . 0
Lime	20 . 0
Carbonic acid and loss	16 . 5
	100 . 0

It is the iron of the blood which is supposed by Berzelius, to give to it its red color.

The blood is said not unfrequently to contain carbonic acid, which is given off when the blood is greatly heated, or if placed under the receiver of an air pump.

Having detailed the general aspect and properties of the blood immediately upon being withdrawn from the body, it will be very necessary to remark, that there are many circumstances which influence the condition of that fluid whilst circulating in its proper vessels. I have had occasion to notice the general estimate as to the relative properties of the serum and the crassamentum: not only, however, do the properties of these vary in different individuals, but in the same individuals at different times, according to the particular state of constitution, or according as it shall be under the influence of disease.

In the first place, individuals are accasionally observed to labour under what is called fulness of blood, or plethora,—the *hyperæmia* of the French,—a condition which seems to consist of the presence of rather more blood than is necessary for the healthy purposes of the system; while on the other hand it occasionally happens, that from some cause or other, there is a marked deficiency of that fluid, or rather a marked deficiency of some of its most important constituents, producing what is called inanition,—the *anæmia* of the French.

These respective states of the system, and the influence they exert in the production, modification, and treatment of disease, will of course be fully considered by the medical professor, and cannot properly be treated in detail here, however important it may be, as it must ever be to him who is engaged in any department of the healing art; I must, therefore, content myself with observing, that in certain forms of inanition, and especially that produced by sudden loss of blood, physiology has suggested, and experience has confirmed, that advantage may be derived and even life itself preserved, by mechanically supplying an individual so situated with a quantity of blood taken from another person. This valuable fact has been proved, and more than once practically illustrated by my colleague, Dr. Blundell; but I confess that we are probably yet unacquainted with the least objectionable mode of performing this *transfusion*, as it is called; neither do I consider it satisfactorily established what precise quantity can be injected, in any individual case, with propriety and safety.

With respect to the more intimate changes which the blood, from various causes, sustains whilst circulating through the body, it is a subject replete with the most intense interest; but is one, nevertheless, which in the present state of our knowledge is involved in the greatest mystery. In ancient times disease was almost universally ascribed to a morbid condition of the fluids of the body generally, and of the blood in particular; and it is not improbable that the moderns have run into an opposite extreme: for that the blood must exercise a most important influence upon every part through which it circulates cannot be disputed; yet it is difficult to conceive how this fluid should become diseased independently of a previously diseased condition of those living solids concerned in digestion and assimilation. But whether primary or secondary, we know, as a matter of fact, that the blood does, from various causes, undergo changes while circulating in its vessels; and we have no reason to doubt, when so changed, that it exerts a powerful influence in modifying and aggravating disease.

A common deviation observed is one, the precise nature of which is little known; and it is indicated by the tardy manner in which the blood coagulates on being withdrawn from the body; in consequence of which tardy coagulation, the red particles quit the fibrin, sink to the bottom of the vessel, and thus give rise to that appearance termed "buffy coat," being nothing more than the fibrin divested of red particles. This state, although generally considered as indicating the presence of inflammatory action, and, consequently, the propriety of abstracting blood from the body, yet is an appearance by no means uniformly to be relied upon in either of these respects. John Hunter, it is well known, was led to a belief in the actual vitality of the blood; and although it may be difficult to accede to such a proposition, yet it will be found, on taking a general survey of the morbid changes which take place in the blood during life, that they all appear to be more or less, if not entirely referable to modifications in the energy of the vital powers, either as connected with original constitutions, or as produced by obvious and serious forms of disease. Thus in a person enjoying health and vigor, the blood, when drawn, usually coagulates speedily, and furnishes a firm crassamentum; but when from any cause the vital powers of the system are powerfully, and especially if suddenly weakened, the blood by no means necessarily undergoes a similar change, but either fails to coagulate altogether or does so in a very imperfect manner; whilst its color is by the same causes almost equally modified. We see this fact exemplified in many instances where the nervous system has received a sudden and powerful shock, as from a flash of lightning; or in cases of death produced by narcotic poisons; in typhus fever too, where the vital powers are greatly sunk, the blood, when drawn, has been found scarcely to coagulate at all, but has presented a dark dingy grumous mass; the little serum that was pressed out, still retaining a few red particles, so as to resemble the washings of flesh. But as to the blood, while circulating in the body, ever becoming actually putrid, there is reason to believe the opinion is erroneous, and has arisen from the rapid changes which the secretions, under such circumstances, undergo. In chronic diseases too we not unfrequently have opportunities of observing remarkable changes to take place in the blood; we observe it in diabetes, and especially in scurvy, in which, as in typhus fever, there exists a singular disposition in the blood to escape from its vessels, giving rise to petechiæ, and vibices or stains, resembling those produced by a bruise. It is right to confess, however, that how far in these instances the condition of the blood is primary, and how far secondary, is a question by no means yet satisfactorily established, although I am disposed to place myself in the ranks of the advocates of the latter.

All that need be added upon this subject is, that recent experiments have shewn the powerful manner in which various agents execute their influence upon the body when injected into the blood-vessels; an influence too, not materially differing from that produced by the same agents when taken into the stomach. Upon this fact it has been proposed to found a novel but energetic mode of administering medicines, when it is desirable to produce a speedy effect, as for example:—a minute quantity of tartar emetic injected into the veins will quickly induce vomiting, and may, therefore, be administered in this way when, from stubbornness or insensibility, the person who has swallowed poison cannot be made to take an ordinary emetic, or merely for the sake of its more immediate operation.

After having treated of the blood, the fluid destined to be circulated throughout the body, we have next to describe the heart, arteries, and veins,—the organs by which the circulation is performed,—and the absorbents, as accessory to this function.

Of the Heart and Pericardium.

On opening the cavity of the thorax the heart does not present itself to view, being enclosed in its proper splanchnic membrane the pericardium.

The pericardium covers the heart precisely in the same manner, as the other serous splanchnic membranes of the thorax and abdomen enclose their respective viscera. It first forms a close covering to the whole exterior surface of the heart, together with the commencement of the large vessels which go out of, and the termination of those which enter into it: from these vessels it is reflected, forming a bag, in which the heart, with its closely investing membrane, is suspended. This position of the heart has not been unaptly compared to the situation of the head of a person enclosed in a double night-cap. The form and size of the pericardium corresponds to that of the heart: it is situated obliquely between the pleuræ; and is bounded in *front,* by the thymus gland, triangularis sterni muscle, and the sternum; *behind,* by the posterior mediastinum and its contents; *laterally,* by the pleuræ, excepting where it is in some measure separated from them by the phrenic nerves; and *inferiorly,* it rests upon the diaphragm.

The pericardium is constructed similarly to the other serous membranes, but is somewhat thicker in its texture, which has led to its division into two layers: an external fibrous, and an internal serous. The external fibrous membrane is in contact with the heart, vessels, pleuræ and diaphragm, and presents an irregular surface, in consequence of the prolongations or attachments which insensibly lose themselves upon the eight blood-vessels which they encircle: the inferior cava having no fibrous sheath, in consequence of its entrance into the auricle through the centre of the diaphragm. This membrane resembles the dura mater in its pearly aponeurotic color: its fibres pass in bundles or separated fasciculi, which intersect each other, and are most visible in the direction of the long axis of the cone. The inner or serous layer lines the external fibrous throughout its whole course, being most easily separated from it where it is reflected from the vessels. It presents an internal, smooth, lubricated surface, forming a closed cavity, into which a serous fluid or halitus is secreted, to facilitate the motions of the heart.

The *arteries* which supply this membrane are derived from various sources: as the phrenic, bronchial, œsophageal, coronary, internal mammary, and not unfrequently from the aorta itself.

The *veins* correspond to the course of the arteries, and principally terminate in the vena azygos.

The *absorbents* pass into glands which are placed at the root of the cava, and origin of the aorta: one large gland is usually found in the situation of the ductus arteriosus.

The *nerves* are with great difficulty traced to the pericardium: they are minute filaments, derived from the cardiac branches of the sympathetic and pneumo gastric nerves.

The *use* of the pericardium is not only for the purpose of facilitating the motions of the heart, but to maintain its proper position under the various situations or attitudes of the body.

The liquor pericardii or fluid secreted by the pericardium, according to the analysis of Dr. Bostock, contains—

Water	92 . 0
Albumen	5 . 5
Mucus	2 . 0
Muriate of soda . .	0 . 5
	100 . 0

This fluid is liable to dropsical accumulations, either from an increased action in the arteries, or a diminished action in the absorbents, similar to the secretion of the other serous membranes. The distention thus produced leads to difficult respiration; and in particular positions of the body, forms an impediment to the circulation of the blood. The reflected portion of the pericardium will sometimes become adherent to the cardiac or close portion by adhesive inflammation. This circumstance also leads to impeded circulation and respiration, under every exertion of the body which tends to a quickened action of the heart.

The Heart.

The heart is a conical, hollow, muscular organ, placed obliquely between the pleuræ; its base being situated superiorly and posteriorly, while its apex inclines forwards, downwards and outwards towards the sternal end of the sixth rib on the left side of the cavity of the thorax. The heart is retained in this situation by its pericardium and great vessels, supported by the diaphragm: it is, however, subject to a slight deviation in its position from the motions of the diaphragm and other parts concerned in the function of respiration, as well as the positions of the body in the erect or recumbent postures.

The figure of the heart is irregularly conical; having an anterior surface more convex than its posterior, and a left edge more rounded than its right: besides which it has an apex and a base.

Its *anterior convex surface* presents in its middle a groove, which divides it unequally into two portions, the larger of which is on the right side. In this groove the coronary artery and vein pass, obliquely from above downwards, and from left to right.

The *posterior surface* is nearly horizontal, resting on the centre of the diaphragm. The posterior coronary artery and vein traverses it in a groove nearly vertically, and unites with the anterior coronary vessels at the apex of the heart. The portion of this surface on the left of the groove is larger than that on the right.

The *left edge* of the heart, thick, obtuse, and rounded, is directed backwards and upwards; while the *right side* is thinner and longer than the left, and rests upon the diaphragm.

The *base* of the heart is placed superiorly and posteriorly opposite to the fourth dorsal vertebra: is slightly inclined from above downwards, and from left to right. It is separated from the vertebral column by the contents of the posterior mediastinum. On the base of the heart, an oblique groove marks the separation of the auricles and ventricles.

The *apex* of the heart passes obliquely to the left into a notch of the left lung, which corresponds to the separation of the lobes, and is marked by a groove or notch, formed by the union of the grooves of the anterior and posterior surfaces. It is the apex of the heart which is felt to pulsate at the interval of the cartilages of the fifth and sixth ribs.

The interior of the heart is divided into four distinct cavities, named the two auricles and the two ventricles. The two auricles occupy the base of the heart, and the two ventricles the body and apex of the organ.

The auricles on each side of the heart communicate with their corresponding ventricles but not with each other, excepting only the two auricles, which, in the fœtal state, have an opening, the use of which is connected with the peculiar circulation of the fœtus in embryo, hereafter to be more particularly described.

The right auricle and ventricle are distinguished from those of the left side by the character of the blood they respectively contain, and by the separate directions in which they are destined to propel it.

In the right there is found venous blood, of a dark modena red color, which is destined to be circulated through the lungs for its decarbonization: this side has therefore been termed the pulmonary or venous heart. In the left side the blood is of a florid red color, having undergone the action of the lungs, and being thus fitted for its transmission to every part of the body, by the action of the left ventricle; hence the left auricle and ventricle has been termed the arterial or systematic heart.

The circumstances which we have already described are observable while the heart is yet in situ; but to observe the more minute particulars of its structure the organ may now be removed from the thorax, together with so much of the large vessels as is necessary to demonstrate their particular connections.

Of the Right or Pulmonary Heart.

First, of the right auricle: it is situated at the inferior, anterior and right side of the base of the heart, and rests on the diaphragm; it is of an irregular figure, and has derived its name of auricle from an imperfect resemblance to the ears of quadrupeds. It has a long axis, placed transversely, terminating anteriorly, between the right ventricle and the aorta, in a lappet or apex, which is named the proper auricle. In order to examine the interior of the auricle, its cavity should be opened in the following manner:—a pair of scissors should be introduced into the superior cava, in order to slit open its anterior wall, extending the opening across the auricle itself, and through the truncated inferior cava; from the centre of this opening a second should be made, at right angles with the first, extending from the middle of the auricle, along its long axis, to the termination of its lappet or apex, which will expose the whole of the interior of the auricle.

The parts first presenting themselves to view, are the posterior larger portion, smooth, and as it were a continuation of the vein, and its anterior part irregular, marked by the deep rugæ or muscular columns of the true auricle: the first is named the sinus venosus, the second the true or proper auricle, or auricular appendix.

The direction of the two venæ cavæ should now be observed. The superior cava is directed forwards towards the opening from the auricle to the right ventricle: the inferior cava is directed upwards and to the left, towards the left side of the auricle, in which situation the foramen ovale of the fœtus is placed. Hence it has been inferred, that the superior cava sends all its blood to the right ventricle in the fœtal state; while the inferior cava, transmits its blood directly through the auricular partition to the left auricle. On the posterior surface of the auricle there are also to be observed, first, at the opening of the superior cava, a tubercle or prominence, directed obliquely upwards and inwards, which is termed the *tuberculum Loweri.* This prominence, although generally found in the lower animals, is sometimes scarcely perceptible in the human heart. The use attributed to this prominence is, to direct the blood of the superior cava into the right ventricle.

The orifice of the inferior cava is furnished with a membranous fold of a semilunar form, termed the *eustachian valve.* Its inferior cornu commences from the anterior surface of the inferior cava; while its superior cornu passes upwards, so as to form the anterior part of the circumference of the fossa ovalis. Its convexity is attached; while its concavity is free, and floating in such a manner as to have led to the belief, that this valve is formed for the purpose of directing all the blood of the inferior cava through the foramen ovale of the fœtus. This valve being found much more developed in the fœtal than the adult state, is supposed to corroborate the above opinion.

Above, the eustachian valve, upon the left side of the right auricle, in that portion which forms the partition between the two auricles, is a depression termed the *fossa ovalis;* which is more distinct above than below, and appears a continuation of the vena cava. The surface of this depression is not always smooth: it presents a thick inferior extremity, which is bounded by the eustachian valve. It is not an imperforate partition; but the opening is so directed, that, after birth, no blood can pass from the right to the left auricle, although the handle of a scalpel, directed from behind forwards, may be directed from one cavity to the other.

Below, the eustachian valve, between it and the opening into the right ventricle, is placed the opening common to the *coronary veins;* which is furnished by a small fold of the inner membrane of the auricle, termed the *semilunar valve.* Its free edge is directed downwards, and is for the purpose of preventing the regurgitation of the blood into the vein.

Anteriorly, the right auricle is furnished with two openings: a smaller one above, leading into the true appendix, which seems to be made up of a number of muscular fibres interlacing each other, forming the true contractile portion of the auricle. The larger opening, which is below, leads into the right ventricle, and is termed the right *auriculo-ventricular opening.* The circumference of this aperture is elliptical in an empty heart, but may be supposed to be circular when the heart is full: it forms the line of demarkation between the auricle and the ventricle, and is marked by a white line, which is termed the *zona tendinea.* There is nothing more remarkable in the right auricle, unless we mention numerous small openings, not furnished with valves, termed the *foramina thebesii.* They have been believed, by some anatomists, to be the terminations of small veins.

The right auricle, therefore, is furnished with four openings: the two cavæ, opening to the coronary vein; and the auriculo-ventricular opening.

The *right ventricle*—comprises the anterior portion of the heart: it is of a triangular figure, the base being directed backwards and upwards towards the right auricle, with which it is connected; while the apex is directed downwards, but not sufficiently forwards as to form the true apex of the organ. The anterior parietes or wall of the right ventricle, forms the anterior convex surface of the heart: its posterior wall is the partition common to it and the left ventricle, termed the *septum cordis.*

To examine the interior of the right ventricle a section should be made along its acute edge, from the base to the apex, and a second incision along the septum cordis, so as to form a triangular flap of the anterior wall of the ventricle attached to its base. On raising this flap, the form of the cavity of the ventricle will be found to correspond to the exterior wall; being larger where it is attached to the auricle, and smaller at its apex.

The parts to be observed in the right ventricle are, first, the irregular surface produced by the muscular fibres passing in various directions. These muscular fibres are divided into two sets: the one set, belonging entirely to the walls of the ventricle, termed the *musculi pectinati*, are destined to propel the blood from the ventricle; being, by their peculiar arrangement and attachments, capable of contracting the capacity of the cavity. The second set, termed *carneæ columnæ*, are somewhat pyramidal in their form, having their bases attached to the sides of the ventricle, while their apices are free and floating within its cavity, being attached only to small tendinous cords belonging to the valvular apparatus of the right auriculo-ventricular opening: by which attachment the adaptation of this apparatus is regulated. At the base of the right ventricle two openings may be observed: the larger posterior one being the *auriculo-ventricular aperture;* and the smaller anterior one, the *opening to the pulmonary artery.* The former is elliptical, and the latter rounded in its form, and are both of them furnished with valves.

The valve of the auriculo-ventricular opening is furnished with three processes or flaps, termed therefore the *tricuspid valve.* It commences in a broad tendinous curtain, termed the *cortina tendinea* from the zona tendinea, which has already been mentioned as the line of demarkation between the auricle and ventricle. This broad curtain is disposed in three flaps, from the inferior extremities of which, little tendinous cords, called the *chordæ tendineæ*, are given off, which are attached to the apices of the carneæ columnæ. These parts entering into the formation of the tricuspid valve, are so arranged that one flap or division is placed anteriorly, a second posteriorly connected with the septum cordis, while the third and largest is to the left, separating the auriculo-ventricular opening from the opening of the pulmonary artery.

It may here be observed, that the upper part of the anterior wall of the ventricle is smooth; and, in conjunction with the third or largest portion of the tricuspid valve, facilitates the direction of the flow of blood directly to the opening of the pulmonary artery.

The opening of the pulmonary artery is small and rounded, and is situated at the highest point of the left extremity of the ventricle. The internal coat of the pulmonary artery is a continuation of the internal lining membrane of the heart; but its middle fibrous coat is connected to the fleshy fibres of the ventricle by three distinct convex arrangements of fibres, marked internally by a white line, from which three *semilunar valves* extend into the artery, forming a complete barrier to any regurgitation of blood from the artery into the ventricle. Each similunar valve is convex and fixed towards the heart, and free and floating within the calibre of the artery, throughout the course of their straight edges. In the centre of each floating edge is a small thickened body, termed the *corpusculum arantii*: the uses of which are said to be for the purpose of filling up the small triangular space, which would otherwise necessarily result from the approximation of the three convex surfaces of the valve.

The pulmonary artery is distributed to the lungs, and completes the circulation of the pulmonary side of the heart. The pulmonary veins arise from the parenchyma of the lungs, as has been before described, and convey the blood by four large trunks to the left or systematic side of the heart.

The Left or Systematic Heart.

The *left auricle* is situated at the superior, posterior, and left part of the base of the heart. In situ it can hardly be perceived, being hidden by the large vessels of the heart; its apex only rising sufficiently forward to the left of the pulmonary artery as to be brought into view. Its form is rather more square than that of the right, and its capacity is about one fifth less. To expose its interior, the four pulmonary veins should be cut open, and the sections continued to the centre of the auricle in the form of a cross. This cavity, like that of the right, contains four surfaces: on the *posterior* surface there is nothing particular to observe, excepting that it receives the right pulmonary veins at its upper part.

The *anterior* surface forms a part of two apertures: one below, the largest, leads into the left ventricle; and above, a smaller one leads to the cavity of the true auricle or appendix; and is marked like that on the right side, by muscular bands, but not so distinct.

The *right* surface forms the portion of the septum between the two auricles: upon it is to be observed the remains of the foramen ovale, less distinct, however, than in the right auricle: it is best seen by holding the septum up to the light; when, from its thinness, it is rendered perfectly obvious.

The *left* surface admits of the opening of the two corresponding pulmonary veins, which are much nearer to each other than those on the posterior surface.

The auriculo-ventricular opening is marked by a white line similar to that on the right side, termed the zona tendinea.

There are, therefore, five openings to the left auricle: the auriculo-ventricular opening, and the orifices of the four pulmonary veins.

The *left ventricle* occupies the posterior and left side of the heart: it is conical in its form, and its anterior extremity constitutes the true apex of the heart. It is somewhat longer, but narrower, than the right ventricle. Its parieties are much thicker, and seem completely to form the septum cordis. To expose its cavity, a section should be made along the left side of the septum, from the base to its apex. The greater thickness of its parieties, and the size and strength of the carneæ columnæ, form a grand distinguishing mark between the two ventricles. The distribution both of the carneæ columnæ and musculi pectinati, are much the same as those on the right side, excepting that they are infinitely stronger. At the upper part of the cavity there are two apertures: the larger is placed posteriorly, and is the left *auriculo-ventricular opening;* the smaller is placed anteriorly, is of a triangular form, and is the *opening into the aorta.*

Around the auriculo-ventricular opening, from the zona tendinea, there descends, as on the right side, the cortina tendinea; but which divides itself into two, instead of three flaps: it is termed the *mitral* or *bicuspid valve,* being fixed by the cordæ tendineæ to the free extremities of the carneæ columnæ, and answers the purpose of preventing the regurgitation of the blood from the ventricle. The larger portion of this valve separates the aortic from the auricular opening; and in conjunction with the anterior part of the ventricle, which is smooth, assists in directing the blood into the aorta. The aortic opening is constructed precisely in the same manner as that of the pulmonary artery; its fibrous coat being connected with the muscular parieties of the heart, while its inner coat is continuous with its lining membrane, and forms three distinct *semilunar valves,* furnished with corpuscula arantii, for the purpose of preventing regurgitation from the aorta into the ventricle. The aorta conveys the blood to every part of the body.

Organization of the Heart.

The heart, we have before observed, is a hollow muscle. It is covered externally, by a strong serous tunic, the pericardium, which has already been described; internally, its cavities are lined by membranes, which are continuous with the inner coats of the blood-vessels, and which is closely connected by dense cellular tissue to the muscular fibres of the organ.

The cavities within the heart are so constructed, that its muscular action is in proportion to the force required in propelling the current of the blood to its ultimate destination. Thus the right side of the heart has walls much thinner than the left, having to propel the blood merely through the lungs; while the cavities of the left side of the heart have walls of great muscular power and thickness, destined to influence the circulation of the blood throughout the whole arterial system of the remaining part of the body.

In the arrangement of the fibres which compose the walls of the cavities of the heart, those of the auricles first claim our attention.

In the right auricle, the muscular fibres form longitudinal bundles, thickest towards the union of the two venæ cavæ, and having in this situation a considerable deposit of adeps between them and the serous lamina of the pericardium. In the proper auricle they pass in isolated fasciculi, between which the walls are semitransparent, similar to the veins. These bundles, from the regularity of their disposition, similar to the teeth of a comb, have been termed the musculi pectinati.

In the left auricle, the muscular fibres are thicker than in the right, and are not so much disposed in parallel bundles, but in fasciculi, which cross each other irregularly, especially those which are deep-seated.

The septum common to the two auricles, is composed of fibres, which are uniform in their direction, and of considerable thickness.

In the right ventricle, the muscular fibres on the external surface appear to take their origin from the auriculo-ventricular opening, and pass obliquely downwards and forwards from the right towards the left ventricle, where they are interlaced with the muscular fibres of the septum: more internally the fibres take an arrangement, somewhat similar to those of the auricles, but stronger, and more numerous; several of which pass off from the internal surface, to form the columnæ carneæ. It is extremely difficult to unravel the muscular fibres of the heart; they are not connected, as in other muscular structures, by cellular membrane, distinguishing their minutest fasciculi; but are minutely interwoven, arising and terminating, more or less, in every part of the organ, yet so as not to be distinctly traced, excepting to the columnæ carneæ.

In the left ventricle, the muscular wall is much stronger and thicker than in the right, its fibres being more apparent on its external surface, passing in a longitudinal direction from its base to the apex. Similar to the right ventricle, its middle muscular fibres take a circular direction, while its internal give off numerous columnæ carneæ; these are most abundant towards the opening of the auricles, but towards the entrance of the artery the ventricle is smooth and even. The left ventricle contributes chiefly to the formation of the septum cordis, bulging so as to present a convex surface within the right ventricle, which may be said to be a fleshy wall wrapped around it. The fibres of the left ventricle take a tortuous course from its base to the apex, and hence are one fourth longer than the distance between these points; the two sets from either ventricle acting in opposite directions, render only one half of the quantity of contraction in each fibre necessary, that would be required had their course been direct; while at the same time it effectually prevents an inconvenient lateral motion.

The motion produced by the muscular action of the ventricles of the heart, tends to draw the apex towards the basis, and their sides toward each other; the septum acting as a side to the left ventricle, while the right ventricle increases the same force by supporting the septum, at the same time it propels its own blood by the contraction of its exterior wall. Hence it is, that the right ventricle terminates on the side of the septum, before the apex of the heart is formed, thus leaving the action of the left ventricle without interference. The muscular fibres of the ventricles are not continuous with the auricles; this may be seen by boiling the heart for three or four hours, when the auricles may be separated from the ventricles, and their distinct arrangement of fibres demonstrated. The arteries arise from the muscular fibres of the ventricles rather abruptly, the fibrous coat of the vessels terminating in festoons, while the serous membrane of the heart connects them externally, and the inner lining of the ventricles internally first forming the semilunar valves.

The heart is supplied with blood from the two *coronary arteries,* while the *veins* correspond to the arteries, and terminate in the right auricle, just below the eustachian valve.

Its *nerves* are very numerous, but small; they are derived from the sympathetic and pneumo gastric.

Its *absorbents* terminate in numerous glands, which are situated between the arch of the aorta and pulmonary artery.

Of the Physiology of the Arteries.

The arteries are elastic tubes, which convey the blood from the heart to every part of the living system.

They are composed of three different tunics or coats, and in certain instances receive a partial covering from neighbouring serous surfaces; as from the pericardium, at their origin, within the bag formed by that membrane around the heart, and from the pleuræ and peritoneum in various situations within the thorax and abdomen.

The *external coat* is elastic, and is composed of fibres resembling cellular membrane, but which are much more dense, and closely interwoven together; and indeed by some anatomists it has been considered to be nothing more than a condensation of the surrounding cellular substance.

The *second coat* is thicker and firmer than the first, and is of a yellowish color; it is called the muscular coat, although it differs materially from real muscle. Its fibres pass in a circular direction around the tube, and like those of the external coat are very elastic, whereas muscle is not. When boiled the arteries are convertible into jelly, but muscular fibre does not undergo this change though boiled for any length of time: the middle or muscular coat is thicker and more contractile in the smaller arteries than in the large, and the external or elastic coat is thickest in the larger arteries.

The *third,* or *inner coat,* is called the membranous; it is thin in comparison to the others, and its internal surface is smooth, polished, and slippery, which offers the least possible resistance to the flow of the blood.

This coat is firm and dense, and appears to prevent transudation, by confining the circulating fluids within the artery: it is also supposed to have a power of maintaining the fluidity of the blood; for any circumstance which destroys its continuity, will produce an immediate coagulation of the blood in the part, as is proved by direct experiment, or the examination of an aneurism in its earliest stage. Its extensibility is not so great as that of the outer coats; hence it is frequently ruptured, causing aneurism. It is this coat which is cut through upon the application of ligatures; and when thus divided, its torn surface hastens the process of adhesion.

In the distribution of the arteries throughout the body, considerable variety occurs, according with the function and other circumstances connected with the economy of individual parts. Upon this account they have been generally divided into two systems, named the sanguineous and the serous. But this division was founded on the supposition, that those vessels which do not convey red particles, convey serum only. More recent observations however prove, that all the elements of the blood may be contained in the transparent vessels; and that even the red particles may exist, though so few in number, and infinitely separated, as to be incapable of reflecting sufficient light to cause the appearance of their red color.

The arterial distribution, generally speaking, is for the various purposes of the growth, nourishment, and peculiar function of each individual part; hence the arteries have various ultimate terminations. They are in general accompanied by corresponding veins, by absorbents, and nerves, and are embedded in a certain quantity of cellular membrane. Five modes of termination are usually enumerated; but from the infinitely minute structures into which the capillary system divides, eluding the highest microscopical powers, it is very possible that we are not acquainted with the real nature of many glandular and other ultimate vascular terminations. Those which are visible are—

First, in *anastomosis*, where one branch uniting with another, gives off succeeding branches, fed by their united currents: this mode of distribution prevails in the mesentery, and tends to equalize the current distributed to the extensive surface of the intestinal canal.

Secondly, in *veins* which return the blood to the heart.

Thirdly, in *exhalents;* which, throughout the skin, produces the matters of perspiration; and, in the serous cavities, the fluids they respectively exhale.

Fourthly, in *cavernous cells* of erectile tissues, as in the spleen, penis, &c. The veins arising from these cells are supposed to be less numerous, thus causing the phenomenon of erection.

Fifthly, in *glandular structures,* such terminations are, generally speaking, involved in much obscurity, and has occasioned great contrariety of opinion. From the ultimate glandular structures, two orders of vessels may be clearly stated to arise: one the veins, which convey the refluent blood; the other the excretory vessel or duct, which conveys the product of each glandular secretion.

There is yet an extensive mode of arterial termination which is not comprehended in the above enumeration: namely, in the general distribution of the capillary system not directly disposed in glandular and secreting surfaces, but which are for the purpose of depositing the different constituents of the organismus, and which are again removed by the circulation and action of the absorbents.

The fluids in circulation are therefore contained in three distinct orders of vessels: arteries, veins, and absorbents; and the union formed by these systems comprise an apparatus named the capillary system, regulated and modified by the alternate distributions of the nerves and their peculiar influence.

In a physiological point of view, the capillary system is by far the most important part of the circulation, being the seat of all the principal functions, as well as the phenomena of health and disease. As yet we are entirely ignorant of the part which the nerves contribute in the performance of the various phenomena resulting from the arterial circulation: all that we can demonstrate is, that when the influence of the nerves is cut off by the division of their main trunks, or deranged in the progress of disease, the various phenomena constituting healthy action, are either deranged or altogether changed. Great difficulty also exists in accounting for the circle completed in the course of the fluids throughout the body; and more particularly in that portion of them conveyed through the veins, absorbents, and capillaries.

In the arteries, the blood is first propelled by the powerful muscular contraction of the heart; the force of which has been ascertained to be equal to the pressure of a column of fluid eight feet in height, or of four pounds upon a square inch of their surface.

The quantity of blood thus propelled, according to Blumenbach, at each contraction of the left ventricle, is two ounces; the whole mass of blood, thirty-three pounds; and the number of pulsations, seventy-five in a minute; which is probably as near the truth as any calculation which has been made: hence the whole mass of blood passes the heart in about two minutes and a half, or twenty-four times in an hour. It must however be observed, that the blood circulates with different velocities in different parts of the system.

Many speculations and idle theories have existed respecting the power which first excites the heart's contraction, and continues through life to maintain its constant and regular motions. The stimulus of the blood entering the ventricles, and the contractility of muscular fibre upon the application of stimuli, seem sufficient to account for its action, without recurring to other, or imaginary causes. The continuance of the circulation in the arterial system, has also been a fruitful source of controversy; and opinions have been advocated between the extremes of considering the arteries as mere hydraulic tubes, subject to the action of the heart, and of considering their action to depend entirely in their own vital muscular powers. The motion of the blood in the arteries is shewn to depend in part on a power foreign to the heart, by the different velocity with which it flows, and the increased force of the pulsation in a part diseased, depending upon the effects of external stimuli, and from a number of internal causes. These facts prove an essential vitality in the artery, and at the same time an alternate state of contraction and dilatation, whether that contraction depends on muscularity in the vessel or not.

It was the opinion of John Hunter that the arteries possessed both an elastic and a proper contractile or muscular power, and that the latter ceased with life, while the former remained as long as the parts retained their structure and composition.

The question resolves itself upon the fact, whether muscularity may or may not exist independent of the peculiar muscular component fibrin, which is not to be detected in the composition of the arteries. Dr. Wilson Philip (*Med. Chir. Trans.* Vol. xii. p. 401.) states that the capillaries may be seen to contract upon the application of those stimuli which produce the contraction of muscular fibre; the same has been observed by Dr. Thompson. Dr. Phillip also observes, that the blood in the capillaries is influenced by stimulants applied to the central parts of the nervous system. (*Expt. Enquiry,* p. 291.—*et seq.*)

I witnessed the following experiment, performed by my friend, Dr. Marshall Hall:—the heart of a frog was removed; then submitting one of its large arteries to a good microscope, it was seen to pulsate for twenty minutes afterwards, which clearly proves that the arteries possess a contractile power for the above period, equivalent to all the purposes of their circulation, independent of the heart.

This pulsating contractile power may be referred to the middle muscular coat, which is supposed to be stronger in the small than in the large arteries; but it is no doubt aided by the elastic external coat.

To the elastic and contractile qualities of the arteries the power of accommodating their volume to the blood contained in them must be attributed. Dr. Hall took seventeen quarts of blood from a horse before it died, in whose body only three quarts more were found, and yet the moment before death the tension of the arteries sustained a column of two feet of blood in his experimental tube. It was observed by Dr. Parry that the artery of a living animal, exposed by dissection to the air, sometimes contracts suddenly to a great degree, and occasionally a single fibre only will contract, affecting the channel similar to a thread tied around it.

The sudden effects of mental influence upon the arteries of the face and neck, in which they dilate, so as to admit red particles, producing a blush, or contract, so as to drive all the red blood from them during the passion of anger or fear, are too remarkable to leave a doubt of the vital action of the arteries; and in these instances their contraction and dilatation is as ready as the action of proper muscles.

Of the Pulse.

The most remarkable phenomenon connected with the arterial circulation, is the occurrence of the pulse, which is simultaneous, in all the arteries throughout the body, with the muscular contraction or systole of the heart. We have already shewn that the action of the heart is not the sole cause of the pulse. Much is to be attributed to the particular construction and properties of the arteries themselves; as may be seen by the continuation of the action of pulsation when the heart has been removed. Nevertheless, it appears by the instantaneous consent of the pulse with the contraction of the heart, that a certain influence actuates the extreme branches of the arteries at the same time with the heart; and this influence can be compared to nothing but a muscular action, the velocity of which, both in voluntary and involuntary muscles, has something in it much resembling the phenomena of electricity.

A pulse may indeed be produced in a dead body, by filling the arteries with water to the tension of life, and then injecting at intervals as much water as the heart throws off blood at a pulse; but the beats, although the artery is fully distended, are very dissimilar from the living pulse: and the same result occurs from connecting the artery of a living animal with the vessels of a dead one.

Parry, in his experiments on the pulse, could not observe, even by the aid of a microscope, the slightest dilatation or contraction of the artery during its pulsation.

Various conjectures have therefore been made to account for the sensible pulsation experienced on pressing the finger against an artery; and although generally considered as produced by the mere dilatation of the artery from the forcible jet of blood thrown into it by the heart, the experiment of Dr. Parry, and its synchronous beat with the heart, shew that this cannot be the sole cause. Bichat refers it to a change of position in the artery, produced by the sudden impetus of the heart's action. Parry, however, denies that the change of position can account for the effect produced. It has been asserted, that the arteries at all times exert a degree of contraction upon the blood they contain, so as to accommodate themselves exactly to their contents; and that when the finger is pressed upon an artery, it interferes with its natural contraction, and the sensation experienced by the finger, termed the pulse, is the consequence. This, however, although it may in some measure account for the increased expansion of the vessel, as the blood is forced under the portion pressed, cannot be considered as the only cause of the effect produced; for without any pressure, the pulsation is distinctly visible in the radial arteries at the wrists, and they have a slight lateral movement towards the ulna at each pulsation; while to the sense of touch, it is accompanied with perceptible dilatation.

The rapidity of the pulse has been compared to the passage of sound. Now, undoubtedly, fluids are elastic, and convey sound more rapidly than the air; and the arteries present an uninterrupted channel or column of fluid, from the heart to their extreme branches; and a shock, or momentum imparted by the heart, might be experienced in the smaller vessels almost instantaneously. Thus the scratch of a pin at one end of a deal rod, is communicated to the ear at the other end of the rod, by the elastic vibration, with a velocity quite equal to any perceptible measurement in the length of the animal circulation. Dr. Arnot has observed, "that an animal's intestine prepared and filled with water, and laid upon a table, or a full vein in a living body, carries a rapid and distinct pulse to a great distance when gently tapped by a finger. The cause of sensation there cannot be the simple forward rush, without tumefaction, described by Dr. Young, and Dr. Parry."

The elasticity of the arteries themselves, may increase the effect of the momentum imparted by the heart; but at the same time, they are disposed in various ways, both to retard or to increase its movements.

Thus the great force with which the blood is first propelled from the heart, is met by the curved form and branches of arteries passing off in acute angles; at a further distance from the heart, they pass off at right angles; while at the greatest distance, obtuse angles prevail. In certain instances, the arteries take a very tortuous course, which both retards the flow of blood, and allows of extensive motion; such, generally, is the distribution of vessels to hollow viscera, and to the lips, &c. In other instances, two currents of blood meet at the anastomosing branch of a vessel, and unite their forces.

From these several causes, there is an evident loss of power in the progress of the circulation from the heart, and which gradually lessens until the flow of the blood in the capillary vessels is in a stream, which is nearly of a uniform current; but which is kept up by the increased vitality and thickness of the muscular coat, and is of such a force as to empty the arteries, and force the blood into the veins, so as to gorge them in the manner in which they are generally found in the dead body.

Some difference occurs in the arterial circulation in the brain, consisting in a provision to prevent the rapid flow of blood. The arteries, as they enter the cranium, pass through tortuous long canals, which prevent a sudden increase of blood. Having gained the interior of the cranium they become thinner, resembling the veins, and having much less of the muscular coat, so that their sides collapse, and tend to oppose and diminish the force of the current of the blood. Another circumstance must be noticed with regard to the circulation in the brain; which is, the mechanical resistance of the bones of the skull, tending to prevent the formation of a vacuum, and consequently, by this power alone, to maintain an equilibrium of fluid circulation. Thus the arteries cannot fill themselves beyond a due proportion, without causing a corresponding diminution in the volume of the contents of the veins; and *vice versa*. Hence it is, that the muscular action of the arteries and the distribution of the veins, are so peculiar within the cavity of the cranium.

In a pathological point of view, the indications of the pulse in health and disease, are of the utmost importance, both to the surgeon and the physician.

These indications may be considered, first, with regard to the number of pulsations in a given time; producing a frequent, slow, intermittent, regular, or varying pulse. Secondly, with regard to the force of the heart's action; causing a bounding, feeble, full, long, or labouring pulse. Thirdly, in respect to the rigidity or tension in the arterial system; producing a hard, sharp, wiry, weak, soft, or yielding pulse. The size of the artery also influences the pulse, and may occasion it to be full, large, strong, small, or weak. The application of these several states to peculiar diseased actions, and derangements of the system, belongs rather to the history of each of such diseases in particular, and would be far too voluminous for the purposes of the present work.

Of the Capillary Circulation.

Having already noticed that the circulation of the fluids of the human body is carried on by the arteries, veins, and absorbents, I consider it right here separately to consider that portion of the above circulation, which is more particularly destined to perform those chemical and vital changes, constituting all the principal phenomena of life itself.

The first, and not the least interesting portion of the capillary circulation, is that part of it which maintains the life of the blood-vessels themselves.

The minute division of the capillary vessels, forms one of those infinitudes, which the human mind feels itself incapable of comprehending. Some idea of it may be entertained by numerical comparisons; but in the attempt to define a limit, numbers themselves are of no avail.

Thus the *vasa vasorum*, which support the arteries, veins, and absorbents, must themselves have their vessels supporting them; and thus we have no conceivable limit to these vessels: and from hence the speculative hypothesis of Ruysch, who imagined that the whole body is composed of nothing but capillary tubes, has received so many supporters.

The most important consideration attached to these vessels is, that as long as the blood flows under the control of the heart and larger arteries, it fulfils no purpose of nutrition or secretion. These important functions reside in the capillary vessels, modified, however, by nervous influence, which in every organ may be supposed to unite with the capillary vessel, in producing the various secretions and excretions of the glandular and membranous tissues. The capillary vessels cannot be assigned to the artery, more than to the vein; nor can we define the limit where the capillary deposits new bone, muscle, or blood-vessel, &c., any more distinctly than the origin of those absorbent vessels which are constantly removing the old materials of the system as fast as the new deposits are supplied.

The change of arterial into venous blood, is not referable either to the artery and vein, any more than to the capillary or absorbent; for indeed, when the circulation is stopped in a limb, its venous hue may be owing to the capillaries supplying the elements, which carbonize the blood in their ultimate action with the absorbents.

The great branches of the arteries, veins and absorbents, together, probably, with the brain and nerves, are all subservient to the functions of the capillary system; while the phenomena of health and disease, the actions of the therapeutical agents, and the processes of nutrition and generation, may all be traced to their origin in the capillary system.

Of the Veins.

The veins are those elastic membranous tubes, which convey the blood from all parts of the living system to the right auricle of the heart, for the purpose of being submitted to the action of the lungs.

They not only convey the refluent blood, which has been distributed throughout the organismus for the purposes of the animal economy; but also the various products of absorption, poured into them by the main trunks of the absorbents. The flow of the blood in the veins is slower than in the arteries, and it will be found that the capacity of the veins is much greater than that of the arteries.

The arteries of a middle size, as those of the leg and fore arm, have each two deep-seated veins accompanying them; besides which, there is a set of superficial veins which take a subcutaneous course, without having any corresponding large arteries.

The proportion of venous to arterial blood, is calculated to be nine parts venous to four arterial.

The veins are composed of two coats: the *external elastic coat*, is formed of longitudinal fibres, which may be readily observed by slitting up a large vein and exposing it to the light of the sun's rays. The muscular contraction of the veins is but slight, a very few fibres only having been discovered, and these in particularly isolated situations. Hence the veins readily collapse, wanting that elastic distention which characterizes the open state of the arteries.

The *internal* or *membranous coat*, is somewhat similar to that of the arteries, but is not so strong, yet is so dense as to preserve the blood within the vessel, and to prevent its transudation. It differs materially from the inner coat of the arteries, in being furnished with numerous valvular folds.

These valves occur in pairs, and are each of a semilunar figure, the convex margin being attached to one half of the circumference of the vein. As the blood flows towards the heart, the valves are pressed against the sides of the vessel; but upon any reflux, they quit the sides, open and press against each other, so as effectually to prevent regurgitation. It will therefore be found, that the valves are most numerous in those situations in which the veins are particularly exposed to the pressure of muscular action, and consequent regurgitation of the blood. Thus they are numerous in the extremities, particularly in those veins which are deep-seated, and less numerous in those which are superficial. They are also found in the iliac veins, in the veins of the head and neck, but not in the venæ cavæ, or the veins of the abdominal viscera. Besides this obvious use of the valves of the veins, they serve to divide the length of the column of blood, and thus to diminish its pressure on the sides of the vessels. This is very obvious in cases of varix, when, from pressure, the vein becomes so much enlarged as to prevent the complete adaptation of the valves; the column of blood becomes continuous, and very much increases the enlargement of the varix.

The veins, like the arteries, have been divided into two sets, the serous and the sanguineous; but, as we have observed respecting the arteries, this division has originated in erroneous suppositions.

The origin of the veins corresponds, in a great measure, with the terminations of the arteries.

First, by direct communication with the *termination of arteries.*

Secondly, from each other, by *anastomosis;* this mode of origin is much more frequent than with arteries; and indeed is so numerous, that when a large vein is compressed, anastomosing branches very readily carry on the circulation.

Thirdly, from *sinuses,* as in the vessels in the cranium.

Fourthly, from *cells*, as in the penis, spleen, &c.

Fifthly, from *glands*, and the general distribution of capillary structures.

Much speculation and controversy have arisen respecting the cause of the venous circulation.

Among numerous hypotheses upon this subject, that which assigns a considerable power of elasticity to the action of the heart itself, is particularly observable. When the heart, by its powerful muscular contraction, has forced the blood from the ventricles into the arteries, the cessation of that muscular effort must be followed by a degree of relaxation, which restores the heart to the state in which it was previous to its muscular contraction; and this is probably justly attributable to the elasticity of the organ itself, assisted by the particular tortuous arrangement of its muscular fibres; or, if not to be attributed to elasticity, it must depend on the muscular contraction of the right auricle, which, being stimulated by venous blood, or nervous influence, excites its contraction in like manner to the contraction of the ventricles excited by the arterial blood to force the blood to the arteries. But in answer to this it may be said, that the right ventricle cannot be stimulated by arterial, as it contains venous blood only: this is true; but the main contraction of the ventricles is resident in the left ventricle, the right being, as it were, superadded or subsidiary to the contraction of the left, with which too its fibres intermingle; and the excitement of the arterial blood of the left, may therefore be sufficient to act upon both ventricles at the same time, independent of the venous contents of the right ventricular cavity.

The auricles have probably an action which draws the blood from the veins, similar to the motion of a piston; at least, it must act in opposition to any effort which would tend to form a vacuum: at the same time, some power may be attributed to the momentum of the blood itself, which, however slight, must be in favour of the auricle. The ventricles have only to exert power enough to draw the blood from the auricle into their own cavities,—a distance so short, that the elasticity of its muscular fibre is probably quite sufficient for the force required.

Bostock seems to consider that anatomy affords no data whereby we can explain the heart's action (*vide* p. 338. Vol. I. *Syst. of Phys.)*; but from an examination of the arrangement of its structure, I am led to consider that its function may be fully accounted for.

The ventricles contract simultaneously, and are so constructed that the stimulus of the arterial blood exciting the left ventricle necessarily operates upon the right, which is so attached that the two ventricles cannot perform a separate action. Had the ventricles been attached to the auricles in the same manner as one ventricle is attached to the other, their contractions would have interfered with each other; the muscular arrangement of the auricles form, therefore, detached pouches, capable of a full contraction, independent of their attachment to the ventricles, and sufficient to draw the blood into them in its passage to the ventricles. The muscular parietes of the right auricle is stronger than the left, in opposition to the muscular parietes of the left ventricle, which is stronger than the right, in each instance being in proportion to the extent of force required in the distance of the motion of the blood.

The flow of blood in the veins, regarding them as mere hydraulic tubes, influenced by the pressure of the atmosphere acting on the weight of the column of blood, together with the elasticity evinced in their external coats, shews that the veins are capable of maintaining a column of blood a few inches above the heart:—this is according to the experiments of Dr. Arnot. Such an hydraulic influence must facilitate the contraction of the right auricle, by lessening the force necessary to fill it with blood; but it must be acknowledged, that whether hydraulic or other mechanical powers assist or not in the circulation, they are all regulated in the nicest manner by the vital influence, adapting the pressure of the vessels upon their contents, and regulating the number of the pulsations themselves; and while such an influence, evidently in constant operation, exists, we know not to what extent mechanical principles can be admitted as influencing vital action.

The motion of the blood in the veins near the heart may be observed in the living animal to consist of alternate states of distention, and collapse: when the auricle contracts, the cava is suddenly distended; and when the auricle receives the blood, the vein is as suddenly collapsed.

Of the Circulation of the Blood.

By the circulation of the blood is meant the course which this fluid takes through the heart, lungs, and blood-vessels of the body; and since the time of Harvey, in the year 1628, it has been ascertained that it is constantly flowing in the same course, and tending toward the same point from which it began. This discovery of the circulation of the blood formed a most important era in medical science, and, indeed, immortalized the name of our countryman.

The term circulation, used absolutely, designates the course of the blood through every part of the body; while the use of the term *greater circulation*, designates the passage of the blood from the left side of the heart, through all the arteries, to be returned to the right side by the veins; while the circulation through the lungs, from the right ventricle to the left auricle, is implied by the term, *lesser circulation.*

Two functions are therefore performed by the heart's action, one to propel the carbonized blood into the vessels of the lungs, and the other to propel the blood, when decarbonized, into the vessels of the whole system; hence both the heart, as an organ, and the circulation of the blood are said to be double, and the terms *pulmonic* and *systemic* have been given to each:—the right auricle and ventricle for the pulmonic, and the left auricle and ventricle for the systemic circulation.

The grand object of the circulation of the blood is to submit the contents of the veins to the action of the lungs, in order that it may be changed to arterial blood; or, in other words, that venous carbonized blood may be freed from that noxious substance, carbon, by a process which appears to require the fluid to be submitted to the influence of the atmospheric air in the act of respiration.

To trace the blood through its progress for this change we commence with it in its carbonized state, brought to the heart by the veins, united in their main trunks, the ascending and descending cavæ, and terminating in the right auricle.

The circulation of the heart then commences by the right auricle becoming distended to receive its blood, which immediately passes into the right ventricle, from the relaxation of the parieties of that cavity upon the cessation of its last muscular contraction.

Probably, now, from the stimulus of the presence of this blood, and certainly from the simultaneous contraction of the left ventricle, the cavity of the right has its capacity diminished, and its contents propelled partly by the septum cordis, assisted by the contraction of its own anterior wall. The blood being thus compressed would have a tendency equally to flow back again into the right auricle as into the pulmonary artery, but for the tricuspid valve, which checks its course in that direction, and therefore it flows into the pulmonary artery. During this contraction of the *right* ventricle another circumstance has to be considered besides the propulsion of its own blood, namely, that it has formed a fixed point for the muscle of the right auricle again to distend it, for its reception of the next portion of blood brought to it by the venæ cavæ.

To continue the passage of the blood through the pulmonary artery, we are to suppose this vessel to contract immediately it has received the blood from the right ventricle. This contraction has a tendency to send the blood back again to the right ventricle; but a barrier, the semilunar valves, oppose this course, and therefore it is propelled into the lungs, there to undergo the process of decarbonization.

Having undergone this process, by what power are we to suppose the blood is forced from the lungs to the left auricle? The answer, I believe is, and founded upon anatomical investigation, that upon the last contraction of the left ventricle, the muscles of the left auricle gain a fixed point, from which the fibres are enabled to expand the auricle; and assisted by the action of the lungs the blood, upon the principle of suction, is drawn through the pulmonary veins into it.

The cessation of the left ventricle's action, upon the same principle, conveys the blood into that cavity; which seems to be evinced by the circumstance, that had the auricle's contraction propelled it, it would have had an equal tendency to send it back to the lungs as to the ventricle, against which there is no valvular apparatus in the veins.

It is the left ventricle's turn again to contract, which it does; and being prevented by the mitral or bicuspid valve from forcing the blood retrogradely into the left auricle, it is driven into the aorta, to be distributed throughout the whole living system.

The circulation is then continued in the capillary system, by a contractile power of their own, which does not terminate until the blood enters, in its carbonized state, the veins which terminate in the venæ cavæ, from whence we commenced.

In this description of the adult circulation, we see that the change from venous to arterial blood, is effected by the intervention of respiration and the action of the lungs.

But the case in the fœtus is very different, in which the act of respiration does not take place in the lungs.

The Process of the Blood's Circulation in the Fœtus.

The blood is conveyed from the mother by the umbilical vein into the fœtus, by passing through the umbilicus and fascia transversalis to the exterior surface of the peritoneum; it then changes its course and passes upwards, continuing to the free edge of the broad ligament to the notch of the liver, and there immediately enters the longitudinal fissure, along which it is directed backwards as far as the transverse fissure; here the vein divides, sending one branch, which conveys (supposing the quantity of blood contained in the umbilical vein as four), three-fourths to the vena portæ; while the remaining one-fourth proceeds backwards in the ductus venosus, along the continuation of the longitudinal fissure to the left of the lobulus spigelii, and empties itself into the ascending or inferior cava, where the four parts meet again, in consequence of the vena portæ having its blood conveyed towards the heart by the venæ hepaticæ, which also terminate in the inferior cava. The four parts of blood, therefore, which had been originally sent by the mother through the umbilical vein, are now conveyed by the inferior cava into the right auricle of the heart; one half of which we will suppose passes directly through the foramen ovale into the left auricle, while the other half passes through the right auriculo-ventricular opening into the right ventricle. This cavity is contracted, and its blood forced into the pulmonary artery; here it divides—one half of it, making one-fourth of what the right auricle contained, is conveyed through a vessel of communication between the pulmonary artery and aorta, which is termed the ductus arteriosus; while the other one-fourth passes into the lungs of the fœtus, and without undergoing the change of adult blood, is returned by the four pulmonary veins into the left auricle. This one-fourth meets the half of the blood which had passed from the right auricle into the left, through the foramen ovale, and the three-fourths are now propelled into the left ventricle, from whence they pass into the aorta, and join with the one-fourth that had passed through the ductus arteriosus from the pulmonary artery into this vessel, and by it, the whole original quantity is distributed throughout the system of the fœtus, to answer all the purposes of nutrition and growth.

A large proportion of the blood is however, returned to the mother by two large vessels, which are given off by the internal iliacs of the fœtus, and are termed the umbilical arteries. They ascend from the internal iliacs by the sides of the bladder, between the peritoneum and parietes of the abdomen, and reaching the umbilicus, come in contact with the umbilical vein; thus completing the umbilical cord.

This cord, it will be seen therefore, is composed of the umbilical vein, which conveys the blood from the placenta to the fœtus, and of the two umbilical arteries, which return it: in this course the vessels are extremely tortuous, and of a considerable length, which varies however from two to even four feet in extent.

The three vessels which enter into the composition of this cord, or navel-string as it is sometimes termed, are bound together by a firm interstitial, cellular-gelatinous substance, which probably answers the same purpose as cellular membrane, and supplying them with vasa vasorum; the whole being surrounded by a sheath from the ammion. The cord is not believed to contain nerves, from the circumstance, that its division neither gives pain to the mother or child. Nor have any absorbents hitherto been traced to it.

The union between the mother and fœtus takes place in the placenta; but it is a remarkable fact, that this union is not to be detected by the finest injections; although, however many young there may be, every fœtus must have its own placenta. The blood brought from the fœtus to the placenta by the umbilical arteries, ramifies within the placenta together with the umbilical vein, until becoming capillary, or infinitely minute, branches unite in that state. The part of the placenta attached to the uterus, is not supplied with blood in the same manner, but derives it from the vessels of the uterus. Injections will not pass from the uterine to the fœtal part of the placenta, nor will it in the opposite direction. There can be no doubt, however, that nourishment is supplied to the fœtus by some communication in the placenta, which has not hitherto been discovered.

Of the Absorbents.

The absorbents form the third description of vessels circulating the fluids of the living system.

They are more delicate, thin, and transparent, than either the arteries, or the veins. They are distributed in every part of the system, and form an abundant portion of the capillary order of vessels.

They are termed absorbents, from the power they possess of imbibing different substances which are exposed to the action of their open mouths, and conveying them to the current of their circulation; which power is named absorption.

This function of the absorbents is exerted in two very opposite ways: in one, they convey matters of nutrition; in the other, their action is wholly excrementitious, in which they remove the worn out solids of the system in the process of growth.

No difference has been hitherto discovered in the structure of either the recrementitious or excrementitious absorbents.

Their appearance is nearly transparent; but frequently they assume a greenish hue, from a portion of bile mixed with the fluids they circulate.

They are composed of two coats, both very thin, transparent, and highly elastic. They are firm and dense, and are able to support a column of mercury twice as high as would rupture the arteries of the same calibre. Their elasticity is shewn by the distance to which they will eject their contents when one of them is punctured.

Their inner coat, like that of the veins, forms numerous semilunar valves, disposed in pairs, similar in structure to the valves of the veins; but, unlike the veins, are constant in their appearance in every part of the absorbent system: the valves are also more numerous, four pairs, and often more, occur in the space of an inch; and between the valves the absorbent swells into a sort of pouch or reservoir, which gives the vessel a knotted appearance, by which it is distinguishable from a vein when injected. The fluids the absorbents circulate, pass from their smaller into their larger branches, and are prevented from regurgitation by their numerous semilunar valves.

The first and most obvious function of the absorbents, is, that of conveying the nutritious products of digestion into the blood, to supply the waste occasioned by the various deposits in the distribution of the arterial circulation. Formerly these vessels were designated by the name of lacteals, from the whitish milky appearance of the chyle upon its first absorption; while the remaining portion arising throughout the rest of the system, were termed lymphatics: but they are all now usually designated by the term absorbents.

The second remarkable function of the absorbents, is in removing the solids of the body, which appear, after a certain period, to be no longer fitted for the purposes of life; this action is evident more particularly in the process of growth, which does not consist in a mere addition to the particles constituting the organismus, but in the constant deposition of new matter and the removal of the old, by the process of absorption. Hence it will be found, that the absorbents are more developed in young persons and much more active, than in the adult; at the adult period, the arteries and absorbents are equal in their action; while in old age, the arterial vigour is slackened and the whole system enfeebled, but the action of the absorbents still continues, and is the cause of that shortening of stature and general emaciation, which usually accompany old age. The cuticle, the nails, and the hair, are probably the only exceptions to this general action of the absorbents: they also are subject to the general law here mentioned, but in a different mode from those structures removed by absorption, as they appear to undergo a species of desquamation, in which their old growth separates as the new is gradually formed; and in the instance of the hairs of the head, when the vessels of their roots have lost their vigour of action, they turn grey, or separate altogether, producing baldness.

The absorbents are also active agents in removing the accumulations of fluids secreted in serous cavities. To this agency may be attributed the rare occurrence of dropsical effusions, which otherwise would be constant: and when these diseases are relieved by the agency of medicines, it is the absorbents which are excited to act more abundantly in removing the accumulated fluid.

A fourth function has been assigned to the absorbents, in their operation upon certain of the secretions, in fitting them more completely for the purposes they are destined to perform. Thus the bile is first received into the gall-bladder in a bland and mild state, and is there subjected to the action of the absorbents in the coats of the viscus, which take up the more watery parts, leaving the active principle of the bile in a concentrated state, and better fitted for its destined uses in the animal economy.

In their distribution the absorbents are similar to the veins, and in general accompany them, both in a deep-seated and in a superficial course. Thus the superficial veins of the extremities, the head and the neck, have absorbents accompanying their larger branches; while to the deep-seated veins there are generally two or more, excepting in the cavity of the abdomen. Here the absorbents quit the veins, and often assume an arborescent or cellular distribution. In the upper part of the abdomen, the absorbents unite, and entering the thorax through the diaphragm, in the aperture which admits also of the passage of the aorta, they form a vessel which gains the name of the *thoracic duct*. This vessel extends up the fore part of the spine, until it reaches the upper part of the thorax, between the aorta and vena azygos; it then inclines to the left side of the chest, passing into the cervical region to terminate in the veins of the neck. Previous to the commencement of the absorbent thoracic duct, it forms a remarkable enlargement, which is termed the *receptaculum chyli*. This is placed immediately behind the right emulgent artery.

The absorbents may therefore be considered as the ultimate channels of the food in the process of digestion, previous to its reception as a constituent of the blood itself. The food taken in by the mouth is digested in the stomach, and from thence conveyed into the intestines; from whence the absorbents take it up in the form of chyle, to be conveyed, as above stated, into the veins.

The origin of the absorbents, as may readily be conceived, must be infinitely various. First, from the inner surface of intestines, for the purpose of absorbing chyle, where they are innumerably distributed on the villi, or velvet-like surface of the inner coat of the intestine. Here they commence in open mouths; and Bell has asserted, that he has counted fourteen on a single villus, and compares them to the puncta lacrymalia of the eye.

From this peculiar formation, various conjectures have arisen to account for the action of the absorbents in taking up chyle only, without any mixture of the excrementitious matter of the alimentary mass. The only way to account for this action is, by supposing that the mouths of the absorbents are incapable of being stimulated to act by any particles but those of chyle; in fact, that they possess a sort of choice, by which they reject the excrement and take up the true nutritious part—the chyle. We are equally at a loss to account for the action of the absorbents in all the other parts of the system; in each of which, excepting the cuticle and its appendages, and perhaps the enamel of the teeth, they appear to act with a constant and irresistible force, removing even the solid structures of the bones.

Two abundant sources of origin give rise to this general distribution of the absorbents; one from the surface of the body, in the common integuments; wherever the veins are large, there the absorbents are abundant and large also. In the scrotum they may be readily injected, by first puncturing the skin, and extravasating some quicksilver. It is from this source that mercurial friction produces such ready effects throughout the system; the absorbents take up the mercury, and convey it to the blood.

The second source of origin of the general distribution of absorbents, is in the cellular and membranous tissues throughout the whole organismus; in stating which, we have probably included every structure which can be named, as cellular membrane is more or less a component of every other structure.

A fourth origin is however yet enumerated by anatomists: this is from the excretory ducts of glands. If the hepatic duct is tied, bile will be abundantly absorbed by the neighbouring absorbents, and the animal becomes jaundiced.

The terminations of the absorbents next claim our attention; and in connection with the recent discoveries and experiments of anatomists, forms an interesting field of physiological research.

The termination of the absorbents at the thoracic duct has already been mentioned: but besides their main trunks, the absorbents have innumerable terminations in veins; this is readily seen by means of injections, and an examination of various substances submitted to the action of the absorbents by direct experiments on animals.

When quicksilver is injected into the absorbents of the intestinal canal, it easily reaches the mesenteric veins and the vena portæ; the communication taking place in the mesenteric glands. This explains the appearance of white chyle, or a substance resembling chyle, which has been frequently observed in the blood of the vena portæ soon after taking food.

It therefore is concluded, that although the thoracic duct forms the main channel for the flow of the chyle, and other substances taken up by the absorbents in the intestines to be carried into the blood; yet a certain portion of those nutritious substances are also conveyed by the absorbents into the mesenteric veins, and by the vena portæ, to be subjected to the influence of the liver.

It must here be remarked, that it appears that the absorbents of the intestines have not only a peculiar power of selecting the nutritious particles constituting chyle, but that they reject other substances which find their way into the absorbents in different situations. Thus odoriferous coloring, and certain saline substances, were found by Tiedemann and Gmelin to be conveyed into the blood of the vena portæ, when they could not be detected in the thoracic duct with the chyle.

In the same manner, the presence of indigo, gamboge and alcohol, cannot be detected in the lacteals or thoracic duct, when they may be abundantly manifest in the blood of the mesenteric veins and vena portæ. From these remarkable circumstances a question arises, as to what means the passage of these substances is effected to the blood, as they cannot be traced by the way of the lacteals and thoracic duct.

In another experiment it was found, that when sulphocyanate of potash had been given to a dog, on opening a branch of the mesenteric vein the saline matter was perceived, but none could be discovered in the chyle.

It has therefore been concluded, but of course only upon conjecture, that the veins either absorb heterogeneous substances directly by their radicles from the intestines, or that they have a communication with the absorbents in the absorbent glands; or that absorbents arising from the intestines terminate in the veins.

That the absorption from the whole system finds its way into the veins by means of the thoracic duct alone, seems highly improbable, if it were merely from the circumstance of its size, which can scarcely be considered as sufficient for the quantity of fluids absorbed; particularly when their action is increased, as under the influence of certain diseases, and the effects of particular medicines.

Several interesting experiments have been performed by Professors Mayer and Bonn, which throw considerable light on the comparative powers of the absorbent system in different situations of the body; and offer a strong proof of the uniform distribution of these vessels throughout the greater part of the living system.

They found that fluids injected into the lungs by an opening made in the trachea, were absorbed more readily in adult than by young animals; and conclude, that the veins must absorb, as these fluids may be detected in the blood before they can be detected in the chyle; and in the left auricle and ventricle of the heart, long before the least trace of them can be detected in the right, and even when the thoracic duct has been tied.

The prussiate of potash injected into the lungs, is first detected in the arterial blood of the heart and arteries; then, if the injection be continued, in the blood of the veins; in the urine, and substance of the kidneys and bladder; in the serum of the pericardium, of the pleura, and the peritoneum; in the synovia, in the milk, and membrane under the skin. After some hours, it may be detected in various solids; the cellular tissue throughout the whole body; in the fat, the serous and fibrous membranes, the aponeurosis of muscles, the tendons, the dura mater, periosteum, &c.; the coats of the arteries and veins, and the valves of the heart; the heart itself, the lungs and the kidneys.

The parenchyma of the liver and spleen cannot be colored blue, neither the substance of the bones and their marrow. The substance of the muscles, and the substance of the brain, spinal marrow and nerves, exhibit no change of color from the muriate of iron.

When prussiate of potash has been given to a pregnant animal, it may be detected in various parts of the fœtus; which proves the fact, that the fluids of the mother deposited in the tissue of the placenta, are absorbed by the vessels of the fœtus, and most probably by the veins.

Considerable light has been thrown upon this interesting subject, by the experiments of M. Magendie and Fodera. Magendie observed that venesection increased the process of absorption in a remarkable degree; and therefore concluded, that a state of plethora, whether real or artificial, by distending the blood-vessels, put an end to the process of absorption, or nearly so. This theory, however, he carried so far, as to consider the veins alone to absorb, and to deny the process of absorption to any other vessels excepting the lacteals, which he considers possess the power of absorbing chyle only; and refers the whole to the mere mechanical process of capillary attraction.

M. Fodera considers, that exhalation and absorption may be referred to two processes, which he terms transudation and imbibition; both processes taking place from the capillary attraction of the parietes of vessels, owing to their porosity; operating, in the first case, from the interior of the vessel to the exterior, and in the second, from the exterior to the interior.

These conclusions are drawn from experiments, which shew a power in veins, arteries and intestines, of communicating the effects of poisons, whether placed on the outer surface of an isolated portion of them, or injected into their cavities, carefully secured on either side of the injection.

Gases enclosed in a portion of intestine taken from a dead animal, and placed on the surface of the intestine of a living animal, will be all absorbed by the living, and its poisonous effects made apparent. If in a living animal an artery or vein is exposed, an oozing is observed, which increases if the vessel is tied with a ligature.

The experiment on which M. Fodera founds his theory of transudation of liquids from the interior or exterior of vessels or membranous structures is the following:—A portion of the intestine of a rabbit was filled with a solution of prussiate of potash, and plunged into a solution of hydrochlorate of lime; and into another portion of intestine he introduced some hydrochloric acid, and surrounded it with sulphuric acid; then he filled a bladder with tincture of turnsol, and placed it in a solution of gall-nuts.

Some time afterwards, upon examination, the following was the result:—In the intestine containing prussiate of potash, hydrochlorate of lime was detected; in that containing hydrochlroric acid, sulphuric acid; and in the bladder containing tincture of turnsol, gallic acid was detected; while in the liquids in which they had been immersed he detected prussiate of potash, hydrochloric acid, and tincture of turnsol.

A similar change of substances may be effected by the pulmonary vein and the trachea of a sheep, injecting hydrochlorate of barytes in the former, and hydrocyanate of potash into the latter; the hydrochlorate of barytes will be found in the bronchi, and the hydrocyanate of potash in the pulmonary artery.

In the living animal, when an injection of gall-nuts or sulphate of iron is thrown into the cavity of the peritoneum or thorax, they may be detected, in the first instance, in the thorax, in the second, in the peritoneum; and the black color formed by the transudation, though not capable of detection in some instances for more than an hour, may be rendered almost instantaneous by the influence of galvanism.

This latter very interesting experiment is performed by placing a cloth, wetted with a solution of sulphate of iron, externally; and internally, in the bladder or intestine of a rabbit, a solution of prussiate of potash; the first communicating with an iron wire, the latter with a copper wire. Matters thus situated, if the communication be made between the iron wire and the positive pole, and between the copper wire and the negative pole, the tissues of the organs become of a Prussian blue color; but if the stream be reversed, the color appears on the cloth. These experiments were varied in many ways, with similar results, and clearly prove the wonderful facility of communication which exists in the capillary system of vessels; but does not, in my opinion, clearly establish, that absorption can be referred to any other order of vessels than the absorbents.

There is yet another extensive mode of termination to the absorbents, namely, in numerous small glands, termed the lymphatic or absorbent glands, which are generally dispersed in clusters throughout the system; they are, however, more numerous and of larger size in particular situations: as in the neck, and around the base of the jaw and occiput; in the arm-pits, and along the course of the larger vessels, as the aorta and iliacs. In the groin there are two sets; one close to Poupart's ligament, and the other above it. They are found at the roots of the different viscera, where their blood-vessels enter: they are very numerous in the mesentery. Like the absorbent vessels, they have a superficial and a deep-seated arrangement: the superficial set are most liable to scrofula; but if schirrus begins in the throat, the deep-seated are most liable to be affected. These glands are of a reddish color, and of an amygdaloidal form: the absorbents enter them, and divide into numerous minuter vessels, disposed within the substance of the gland; convoluted, and coiled back upon themselves in various ways. The gland is composed of numerous small cells, filled with a whitish fluid, which the absorbents take up and convey by their branches which pass out from the gland: the absorbents entering are termed *vasa inferentia*, while those which pass out are termed the *vasa efferentia*. Besides these, several absorbents pass over the exterior of the gland, and are capable of carrying on the circulation when the gland itself is inflamed or swelled, which is a very frequent occurrence.

The exact office of the lymphatic gland is not well understood; it may however be observed, that the contents of the absorbents are every where submitted to the action of these glands before it enters the blood; and in some instances, as in the mesentery, appears to pass through several of them before it reaches the thoracic duct, to terminate in the blood-vessels. It has been observed, also, that the fluid in the vasa efferentia is more coagulable than in the vasa inferentia; the absorbent glands may, therefore, perform the office of assimilating their contents, so as to approximate them to the nature of the blood. The absorbent glands also exert an office upon the matters absorbed, which separates deleterious substances: thus, the venereal virus will be arrested by the glands of the groin; and until they, in consequence, become themselves diseased, the poison is not conveyed further into the system.

The serous fluid or lymph contained in the absorbents was considered by Haller to resemble the serum of the blood; it is coagulable by heat, alcohol, and acids. When exposed to the air, on cooling, it separates into two parts; one which forms a gelatinous coagulum, and sinks to the bottom; while the other is much more abundant, fluid, and floats at the top. The coagulated mass is semitransparent, and of a pinkish color; it possesses different properties when the food has been vegetable or animal: from vegetable food it is transparent, contains carbon, and is not easily passing into a putrid state; from animal food it is milky, very putrescent, and besides albumen, contains a matter resembling cream, furnishing carbonate of ammonia by distillation.

The absorbents are supplied similar to the arteries and veins with vasa vasorum, which may be traced on the thoracic duct; their glands have numerous arteries and veins distributed to them, and from them derive their reddish appearance.

Having now finished the pathological considerations respecting the organs destined to circulate the fluids of the body, it will now be proper to treat, in a cursory manner, the pathological facts connected with them.

In speaking of the situation of the heart I have already stated, that its base is directed backwards towards the fourth dorsal vertebra, remote from the sternum; and that its apex projects forwards, so as to be felt striking against the parieties of the chest, in the space between the cartilages of the fifth and sixth ribs: that the alternate contraction of the auricles and ventricles is accompanied by a peculiar sound; and that the movements of the heart observe a regular order of succession. Now as these circumstances may all deviate, more or less, in consequence of disease, it becomes of the greatest possible importance, carefully to investigate and to remember the phenomena usually presented, in all these respects, in a state of health.

It is in fact upon a knowledge of these phenomena, depending upon the healthy action of the heart, that has lately been founded a novel but ingenious mode of investigating the diseases of this organ. This is by means of what has been called *auscultation;* which may be either immediate, by applying the ear to the chest; or mediate, and performed by means of a hollow tube or cylinder, called a *stethescope*—

an instrument invented by the late celebrated physician Laennec.

It is not to be expected that in this work I should enter into detail on this subject; but I may observe, that the derangements of the heart, which are investigated and determined by the aid of auscultation, are referrible to the four following circumstances:—*First,* the extent to which its pulsations are audible; *secondly,* the impulse or force with which it appears to strike the parieties of the chest; *thirdly,* the sounds emitted during the contraction of its auricles or ventricles; and *fourthly,* its *rhythm,* as it has been called; or, in other words, the order and succession, as well as the duration of its respective movements.

It is also right to mention, that this mode of investigating disease was, by the same distinguished physiologist, applied with extraordinary success in explaining the diseases of the lungs, and of the contents of the cavities of the chest generally.

Auscultation will, by habit, acquaint the medical man with the knowledge of which of the cavities of the heart emit each particular sound. In a healthy subject, if the stethescope be applied either between the cartilages of the fifth or sixth ribs, or upon the inferior extremity of the sternum, a distinct sound is emitted; or rather, it may be described as a double sound, which correspond with the arterial pulse. One of these sounds is described by Laennec as being "clear and rapid, and somewhat resembles the sound produced by the valve of a pair of bellows: this corresponds to the contraction of the auricles. The other is more dull and prolonged, coinciding with the beat of the pulse, and with the shock communicated to the parieties of the chest by the motions of the heart: this indicates the contraction of the ventricles." The sound produced by the right side of the heart, is most audible at the inferior extremity of the sternum; and in the interspace of the cartilages of the fifth and sixth ribs, that of the left side.

Bearing in mind the situation, action, and sounds of the heart in its healthy state, you will, in some measure, be able to recognize and appreciate those deviations indicative of disease. The heart, like other organs of the body, may be involved in merely functional, or it may be the subject of organic disease: the former is by far the most frequent, its frequency being nearly in the ratio of the nervous susceptibility of the individual. Hence the great prevalence of functional disorder of the heart in delicate hysterical females; and hence those occasional alarming disorders of the heart incident to dyspeptic and hypochondriacal men. In these cases, whether arising from mental emotion or from sympathy with some other disordered part or organ of the body, the action of the heart is observed to be suddenly affected with violent inordinate action, striking the ribs with great violence, and apparently extending its impulse over a very considerable space of the chest; at other times, under such circumstances, instead of palpitation, there is merely what appears to be a morbid sensibility of the breasts, so that without any great violence of action or irregularity, the patient is conscious of each impulse of the heart, which we know is not the case in perfect health; whilst in other instances, again, the heart, instead of promoting its natural rhythm, appears suddenly to stop for the period of one beat, and thereby to give rise to what has been called intermission of the pulse; and lastly, the heart may be affected with severe pain, or what has been called neuralgia; a pain not necessarily accompanied even by irregular action, but a pain unfortunately not unfrequently associated with hopeless organic disease of the organs.

Now in such cases as these we find the nature of the disease indicated, or at least rendered probable, not only by the sex and state of constitution of the individual, but by the absence of those signs by which organic disease is usually recognized.

It is hardly necessary to observe, with respect to organic disease of the heart, that it is various, and that it may affect any of the tissues entering into the composition of the organ; or what is more common, it may affect one of them at the commencement, and then extend to the rest, either from continuity or from the disturbance of the peculiar function of any particular part.

The pericardium is subject to inflammation, and very frequently following rheumatic affections, leading to the belief that a real matastasis occurs. The symptoms accompanying peracarditis frequently offer considerable difficulties to the formation of a just diagnosis; as the heart itself, pleura, and even the lungs, may present signs of disease.

The heart is sometimes the subject of general increase of the substance of its muscular parieties, without any dilatation of its cavities: this is termed hypertrophy of the organ, and may affect either ventricles, auricles, or both; but most frequently the former only.

The converse to hypertrophy is that disease, which, in the place of the great thickening of the muscular parieties of this organ, exhibits on inspection a dilatation of its cavities, and a corresponding thinness of its walls. This disease has been termed by Corvisart, passive aneurism; and here, in most cases, is subjoined a disease, which may however exist, independent of dilatation—a softening of its muscular structure, known by the expressive term of a "flabby heart."

Besides those diseases which affect the structure of the heart generally, we may mention those equally important affections, in which the different valvular apparatus of the organ become obstructed in the performance of their peculiar function by ossific deposit, or changes consequent upon acute or chronic inflammation.

The valves of the left side of the heart are more frequently the subject of these organic alterations, than those on the right; so frequently, in fact, found in the old subject, as almost to justify the opinion, that they are amongst the natural changes of old age, than the result of any definite disease. But the valves at an earlier period of life become thus affected; such thickening takes place, either around the auriculo-ventricular opening, or at the ostium aortæ, as not only to diminish the proper area of these openings; but even sometimes, as related by Laennec, as almost totally to obstruct them. The result of this would be, first, to produce a dilatation of the left ventricle, from the inability of the organ to discharge its blood through the diminished opening; and further, to increase its muscular thickness, from its frequent efforts to carry on the circulation.

It would be obvious, from what has been said of the valvular diseases of the left side, that dilatation and hypertrophy of the right, would necessarily occur under similar disorganization of its valve.

It is right however to say, that the opening of the pulmonary artery is much more rarely diminished in diameter than that of the aorta; and that instances are but seldom met with of bony and cartilaginous deposits in the tricuspid valve of the right auriculo-ventricular opening.

But besides the diseases of the valves, various other causes which might impede either the passage of the blood through the general or pulmonary circulation, would necessarily produce derangement of those cavities destined to transmit each portion of the circulating fluid.

The heart is liable to rupture of its parieties, from inordinate muscular action: this disease is, fortunately, so rare, as to have induced Laennec almost to doubt its existence. Some well authenticated cases have, however, lately been recorded by Dr. Farre, in the first number of his "Journal of Morbid Anatomy;" which would lead us to believe, that softening of the heart had previously taken place, and that during violent moral excitement, it had given way under the muscular impulse. Previous ulceration sometimes leads to the same result.

Ossification of the coronary arteries, is supposed to be the common cause of the disease termed angina pectoris; although there is reason to believe, that it is not unfrequently a consequence of disordered function.

Malformations of the heart most frequently tend to the intermixture of the venous and arterial blood; this may arise either from the permanence of the foramen ovale, an unnatural opening through the septum cordis, or pervious state of the ductus arteriosus. The blue color of the skin, well known as the morbus cæruleus, and the immediate effects on respiration, and sometimes even syncope, produced by excitement, are the most common symptoms arising from such causes.

There are certainly no circumstances connected with disease, or accident, which so promptly require surgical assistance, or are so appalling to the patient, as hæmorrhages; it would be therefore a great dereliction of my duty, were I to fail giving some account of those diseases which tend to produce this effect, and which have their seat in the blood-vessels.

The arteries, the organization of which I have already given, were described as being composed of three separate coats of different structures, and as being supplied by their own blood-vessels, nerves, and absorbents: hence it must necessarily occur, that they are subject to all the diseases incident to their peculiar textures.

When inflammation attacks an artery, it may terminate, as in other parts of the body, either in adhesion, suppuration, ulceration, or mortification.

It is by the adhesive inflammation that wounds of arteries are repaired after the amputation of a limb, and their calibres become obliterated upon the application of a ligature: also when subjected to pressure from any neighbouring tumour, or from abscess. It is this adhesive process, therefore, which admits of the performance of the numerous surgical operations, and which, in fact, prevents the slightest accident, that may affect an artery or vein, from proving fatal through the hæmorrhage which would otherwise occur.

Inflammation does not, fortunately, often terminate in ulceration of the coats of arteries; and it may be said, perhaps, never to occur, unless there has been some previous morbid affection. The deposition of calcareous substances will sometimes lead to such an ulceration, as completely to destroy the coats of the vessel, and lead to what is termed a spurious aneurism.

Cancerous and phagedenic ulcers may also give rise to fatal hæmorrhage from the same cause.

The internal coat of an artery, which in structure bears so much resemblance to serous membranes, may be supposed, like them, sometimes to lead to the formation of pus; but which, being immediately poured into the interior of the vessel, would necessarily be washed away with the stream of blood, and therefore could not be detected.

The deposit of bony matter in the coats of an artery, is so frequently found on the examination of old subjects, as to have led some surgeons to consider it a necessary consequence of old age; but it is a change, certainly not invariably attendant on a state of protracted existence. It is sometimes, although very rarely, met with in the arteries of young persons, and seems to be generally produced by excessive stimuli to the action of the heart and arteries, by hard drinking or violent athletic exertion.

Previous to the deposition of earthy matter, there invariably occurs a formation of a substance very similar to cartilage; which, as in the natural development of the osseous system, forms a nidus for the deposition of earthy particles; at which period, the artery becomes opaque, and loses its natural elasticity as well as its semitransparency.

The deposition of bone is sometimes so considerable, as to render the artery a complete osseous tube; while at others, it will form irregular patches only: in either case, it gives rise to a change in the force as well as in the regularity of the circulation; and sometimes to an extent so great, as to lead to mortification in a distant part. Under these circumstances, we not unfrequently find that old people lose their toes, and even their feet.

There is a disease peculiar to arteries, in which they lose their elasticity, and are rendered incapable of circulating their natural supply of blood, by which they become permanently distended. Children are occasionally born with this defect in the superficial vessels of different parts of their body; and the disease has, from a vulgar notion of its being connected with mental affections of the mother, been termed nævus maternus. This disease varies not only as to its extent, but also as to the structures which it may involve. Sometimes, for instance, it will assume the form of a superficial stain, and appear as if it depended upon some morbid change in the rete mucosum; while at others, it seems to consist of clusters of enlarged anastamosing veins, forming distinct sacs of blood: in some, again, large distended arteries will be found running into the diseased structure; if these formations be cut into, they resemble, in appearance, the interior of the spleen. When nævi are small, and are situated over bone, they may, by the application of pressure, combined with the use of restringent lotions, be altogether removed. Applications of caustic, setons, and even the inoculation of vaccine matter, have all been recommended as means of cure. Where they evince a tendency to enlarge, and become troublesome from their increase, and danger of bursting, extirpation is the only means to be employed for their removal; and this may be performed either with the knife, or by means of ligatures. When they are so large that the surgeon has any reason to fear hæmorrhage during the operation, the ligature should be employed; and particularly when the patient is very young.

Sir Astley Cooper and Mr. Brodie both, I believe, recommend the application of ligatures; but whether these or the knife be employed, great care should be taken, that, in the first instance, every portion of the diseased structure be included; or where the use of the knife is preferred, that it be perfectly extirpated; otherwise the disease will rarely fail to return.

The most important of the morbid changes to which the arteries are liable is, a dilatation or yielding of some part of their structure, constituting a disease which is termed aneurism.

An aneurism may therefore be defined to be a pulsating tumour, communicating with the interior of an artery, and containing blood.

This disease may attack either the arteries situated within the cavities of the body, or the vessels supplying the extremities or superficial parts. In the former case, the disease is termed an *internal,* and in the latter, an *external aneurism.*

The symptoms which are induced by an internal aneurism, will depend upon the altered function of the viscera, or different organs upon which the tumour may press. The diagnosis will therefore be formed by an examination as to the presence of a pulsating tumour in the course or situation of a large artery, or in the vicinity of those organs, the altered function of which may be explained by the pressure of such a tumour.

In such cases, where an artery cannot be subjected to the application of a ligature between the swelling and the heart, for the purpose of preventing the flow of blood into the tumour, one of two modes of treatment alone can be applicable; namely, either to apply a ligature on the *distal* side of the tumour, with the hope that the inflammation may extend so as to obliterate the aneurism, or merely by palliative means to protract the period of destruction which must follow the spontaneous bursting of the tumour. The means which are employed for this latter object, consist in diminishing the frequency and force of action of the heart and arteries by general blood-letting; this, however, must be done with considerable caution, to an extent merely to produce that object without increasing the irritability of the system, which would tend to increase the frequency of the pulse, although it might diminish the general force of the circulation.

When an external aneurism has formed, it may be known by the appearance of a pulsating tumour in the vicinity of an artery, which may be partly emptied of its blood by pressure on the vessel above it; as well as by its immediately becoming again distended upon that pressure being removed. An enlarged gland, or any other tumour situated immediately over an artery, may receive such an impulse from the vessel as to lead to some difficulty in the diagnosis; but in these cases, a firm and steady pressure on the tumour diminishes its pulsation: while in aneurism, the same degree of pressure renders its pulsations even more perceptible. In the abdomen, however, there is frequently considerable difficulty in deciding whether the tumour communicates with the interior of the artery; or whether it merely receives an impulse from its contact with the aorta. The position in which you examine your patient, in these cases, will probably lead to the safest and surest mode of forming a diagnosis: first, examine your patient on his back, and try, by different degrees of pressure, to ascertain whether the pulsation be from the blood passing through the tumour, or only communicated by the parieties of the aorta. Then desire your patient to place himself upon his hands and knees, in that position commonly called "*on all fours*," when, if the pulsatory motion of the tumour depends only upon its vicinity to the aorta, it will usually, from its own weight, fall from the vessel, and either entirely lose, or have its pulsation very much diminished; whereas if it be of an aneurismal nature, the pulsation will remain the same.—To return, however, to the subject of external aneurism: being satisfied with the nature of the disease, there is nothing left to be done than to prepare your patient for the operation of the application of a ligature around the vessel, between the tumour and the heart. The mode of performing this operation upon the different arteries in the body, I shall not describe until I speak of the distribution of the arterial system.

To enter into the detail of the progress of aneurism, from its commencement to its termination, is more than the limits or intention of a work on anatomy can admit of. My object therefore, has been that of furnishing as much as would be sufficient to interest the student, and induce him to consult surgical books upon the subject for more perfect information.

Aneurismal varix, is an accident which occurs from bleeding, and generally in the median basilic vein, the point of the lancet passing through the vein into the artery. The effect of this accident is to produce an adhesion of the two vessels, with an opening of communication between them. In a few days a tumour, about the size of a small walnut, of a bluish color, presents itself, possessing a peculiar tremulous motion, and to the ear communicating a whizzing sound.

This tumour, when pressed upon, disappears; if the vein be compressed above it, the swelling increases in size; and if the artery be compressed in the same situation, the pulsation of the tumour entirely ceases, but returns immediately upon the pressure being removed.

This disease but rarely occurs, and only two cases are recorded as being the result of any other accident than from careless venesection: the one, of a blacksmith's boy, who had the femoral artery wounded, with its vein, by the sharp end of an iron rod: and the other case, was of a dragoon, who received a pistol ball in his right ham, and which, either at the time or from after-sloughing, produced a communication between the popliteal artery and vein. Both of these cases are related by my friend Mr. Hodgson, in his valuable work on the "Diseases of Arteries and Veins."

Such cases will sometimes lead to no inconvenience, but the patient is enabled to follow even laborious occupations, without any other sensation than that of occasional numbness of the affected limb: but, even under such circumstances, the tumour should be defended by mechanical means from external injury; for should the tumour burst, either in consequence of over-distention or of any external injury, the artery must be secured both above and below the opening of communication with the vein.

Compression has also been known, in some cases, to produce an effectual cure, and should therefore always be employed in the first instance; raising the arm at the same time to facilitate the flow of blood through the veins, and making use of such remedies as will tend to diminish the action of the heart and arteries.

Veins are frequently subject to an enlargement or dilatation, from an accumulation of blood, or rather, it may be said, from their parieties not being able to sustain the weight of the additional columnar height which they are required to support, from a want of juxtaposition in the valves rendering them incapable of performing their usual office. This disease is termed a varicose state of vein, and is most commonly observed in depending portions of the body; as, for example, in the veins of the scrotum, and those of the lower extremities.

Under this affection, the veins not only become much enlarged, but excessively tortuous in their course; which seems as it were, by a provision of nature, to serve the purpose of dividing the column of blood, and then of taking off a portion of the accumulated weight from the sides of the diseased vessel.

In such cases, the skin frequently becomes hard and dry, desquamates so as to expose the true skin, and sometimes leads to suppuration, producing hæmorrhage and troublesome ulcers.

Relief may almost always be obtained by placing the limb in an horizontal position, and supporting the veins by the application of a roller; and if ulcers be formed, the black or yellow wash will be found highly efficacious.

As to medical treatment, the bowels should be kept freely open, for obstinate constipation is one of the most frequent causes of the disease; thus we may explain the much more frequent occurrence of this affection in the spermatic veins of the left side, and in those of the left lower extremity, from the accumulation of fæculent matter in the sigmoid flexion of the colon retarding the return of blood through the left iliac vein. The peculiar termination of the left spermatic into the emulgent vein, may also tend to render varicocele more frequent on the left, than on the right side of the body.

The veins, like the arteries, are liable to become inflamed, and are therefore exposed to all the consequences of inflammation. It is the internal coat which is most frequently affected, and particularly after bleeding, when the inflammation will sometimes extend to larger trunks, or even to the membrane lining the cavities of the heart.

The result of inflammation of the internal coat of a vein is sometimes, although rarely, the obliteration of its calibre from the effusion of adhesive matter, so that the vein is converted into an impervious cord: at other times, pus is secreted, which may either be carried into the circulation, or it may induce adhesions in different parts of the vein, so as to lead to the formation of a chain of small abscesses.

My respected friend, Mr. Professor Coleman, has remarked, that when inflammation of the jugular vein follows bleeding in a horse, the inflammation extends in the direction of the animal's head; while, in the human subject, it invariably takes place towards the heart.

But it is also worthy of notice, that such ill effects rarely follow the operation in the horse, unless the pin which is used to stop the bleeding be very improperly passed through the coats of the vessel, instead of including the skin only.

If the inflammation of the veins be not very extensive, strict adherence to the antiphlogistic regimen, assisted by the application of leeches, and the administration of calomel and opium to allay irritability, will usually produce a cure. John Hunter has treated with success a case which appeared as if the inflammation were extending rapidly, by applying a compress on the vein; and thus, by inducing adhesion of its sides, checked the progress of the disease.

When, however, inflammation extends to large veins, and the suppuration is considerable, a very high degree of constitutional irritation is set up, and the patient usually sinks with symptoms very similar to those of typhus fever. This I have frequently seen in cases at Guy's Hospital, where the pupils have wounded themselves in dissection, or in *post mortem* examinations: and on referring to my notes on this subject, I find that those who have fallen victims to this disease, have been generally from abroad, and from warm climates, in whom we should expect increased irritability, with a diminished power of constitution.

There is sometimes found a general enlargement of all the coats of a vein, giving rise to a distinct fluctuating tumour; this state of dilatation is termed varicose aneurism. Sir A. Cooper, in his surgical lectures, mentioned two such cases that were admitted into St. Thomas's Hospital: the one was situated in the neck of a woman, and its bursting caused her death from hæmorrhage; in the second case, the tumour was situated in the popliteal region of a man who was admitted under the care of Mr. Birch; this tumour pulsated, and the limb was amputated, when it was found to be a varicose aneurism, pulsating merely from its vicinity to the artery. These diseases might be mistaken for aneurismal varix, but the diagnosis may be formed from the following circumstances: empty the tumour of its blood, and compress the artery above it; if it be aneurismal varix, it cannot again become filled with blood until the pressure be taken from the artery; but if varicose aneurism, it will become immediately refilled: besides, the absence of the whizzing noise is another diagnostic mark.

It was said by Bichat, that the veins were not exposed to ossification, like the arteries; but there is scarcely a museum in Europe, which does not afford a practical refutation to the assertion of this physiologist. In St. Thomas's Hospital is a preparation of the saphena major vein, taken from a subject brought accidentally into the dissecting room, in which the vessel is seen to be completely ossified for a considerable part of its course. It is a well known fact, that the membrane lining the right cavities of the heart, which approximates in structure and function to the internal tunic of the veins, is very rarely found ossified, even in those subjects in whom there would seem to exist a remarkable tendency to the disease; while, on the other hand, the membrane lining the left cavities participates with that of the arterial system generally, in a strong disposition to ossification.

The diseases of the *absorbents* are few; but at advanced periods of life they invariably become opaque, instead of retaining their natural transparency, and seem therefore to undergo a change approaching at least to disease. By physiologists, however, it is usually considered, that in old age the absorbent system is particularly active, but this is not the case; for notwithstanding the fact, that at this period several parts of the body are removed by the absorbent vessels, it is not to be attributed to their increased action, but rather to the diminished power of the arterial system; so that the equilibrium between the arterial and absorbent system, which exists in the adult period, is lost in old age, from the loss of the power of the arteries; and a wasting of the body therefore ensues.

The absorbents are the subjects of inflammation, and from very slight causes, such as from friction, chafing, or slight wounds, which will produce knotted red lines in the course of the absorbents, along the inner side of the extremities. The knotted enlargements point out the situation of the valves. Incised wounds but rarely produce inflammation of the absorbents; but small punctured wounds in irritable constitutions, are frequently productive of the most alarming symptoms, and sometimes of death. Hence it is, that it is not unfrequent to hear of persons, from merely pricking the finger in working, or with a nail, or fish-bone, dying. In the prosecution of anatomical investigations, it is well known that a wound from the hooks, or a puncture from the end of a rib, or any piece of bone, is much more dangerous than a cut with the dissecting-knife; which has led some to believe, that the ill effects are produced by the absorption of morbid matter. I cannot, however, bring my mind to believe this to be the cause of danger, but would rather attribute it to the peculiar state of the constitution at the time of the injury: which opinion is more or less corroborated by the fact, that if several be wounded from the dissection of the same body, one only is frequently affected. A puncture should therefore be immediately converted into an incised wound, whenever there is any reason to believe the subject of the accident is irritable; fomentations should be applied, the bowels gently opened, calomel and opium administered at bed-time, and change of air immediately be resorted to. Sir Astley Cooper usually recommended the pupils to apply nitric acid to the puncture: this practice, I must say, I deprecate; as I have frequently seen inflammation of the absorbents immediately take place upon the application of this second irritating cause.

The absorbents are occasionally obstructed by the formation of malignant tumours: in the museum of St. Thomas's Hospital, there is a preparation of a malignant tumour of the size of a walnut, obliterating the thoracic duct; it was taken from the body of a man who died of a fungoid disease of the testicle. Two other instances of obstruction are mentioned by Sir Astley Cooper: one of a tumour formed in the receptaculum chyli, of a scrofulous nature: and in the second case, the valves of the duct were very much thickened.

The absorbent glands are also very subject to inflammation, both from the irritation produced by abraded surfaces, and from wounds, as well as from the absorption of specific poisons. We have instances, frequently, of swelling of the inguinal glands from chafing, as after hard riding; and the formation of buboes from chancre, may be instanced as an example of the second cause.

Ossific depositions not unfrequently take place in the glands, and sometimes in such a quantity, as to convert them very nearly into bone. In the museum of St. Thomas's Hospital, there is a gland, taken from the groin of a woman, which weighed fourteen pounds. The mesenteric glands are also sometimes found to contain portions of bony or earthy matter.

END OF VOL. THIRD.

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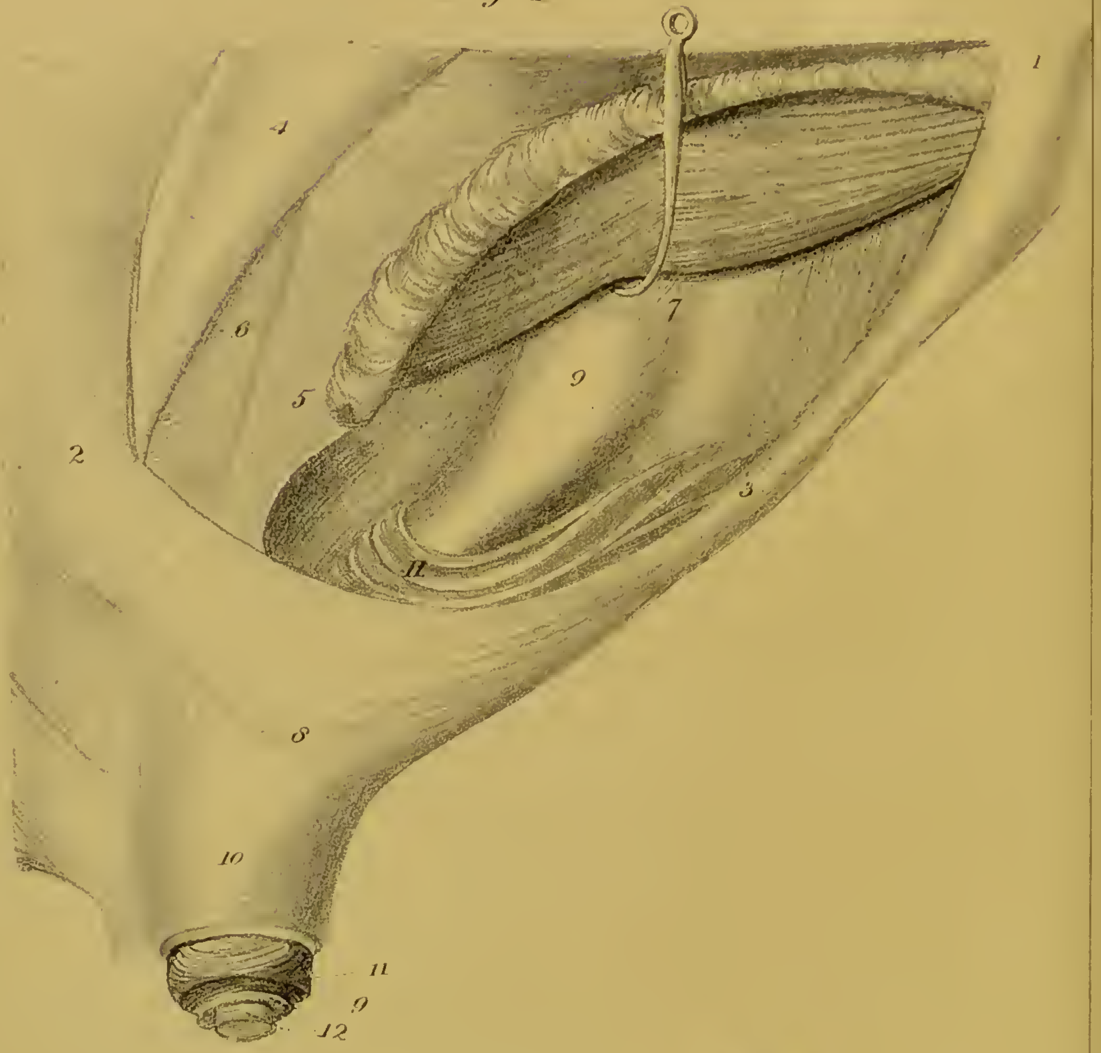
PLATE 1.

Fig. 1



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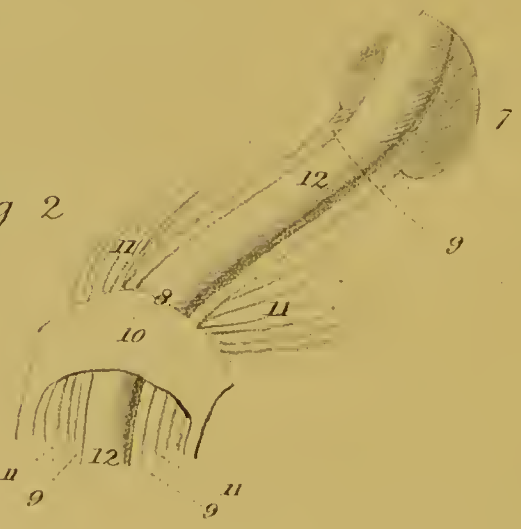

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PLATE I.

Fig. 1.

The fasciæ spermaticæ given off from the rings of the inguinal canal.

1. The anterior superior spinous process of the ilium.
2. The symphisis pubis.
3. Poupart's ligament.
4. The tendon of the external abdominal oblique muscle raised.
5. The united tendons of the internal oblique and transversalis muscle.
6. Sheath of the rectus abdominis.
7. Internal ring.
8. External ring.

9, 9. The fascia spermatica interna.

10. The fascia spermatica externa.

11, 11. The cremaster muscle situated between the fascia spermaticæ.

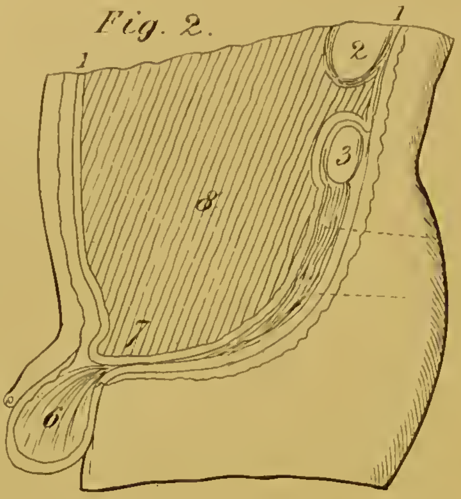
12. The spermatic cord.

Fig. 2.

A diagram of the parts in Fig. 1.; the references being the same from 7. to 12.

PLATE. II.

Fig. 2.



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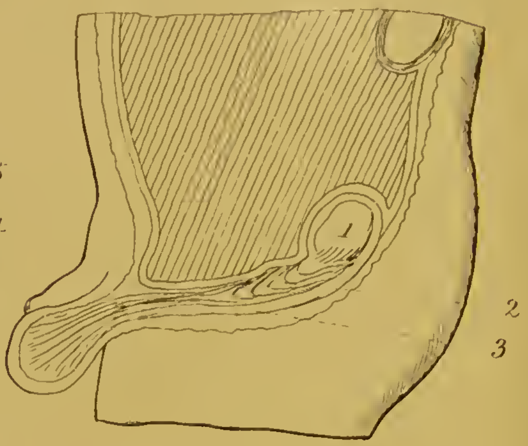

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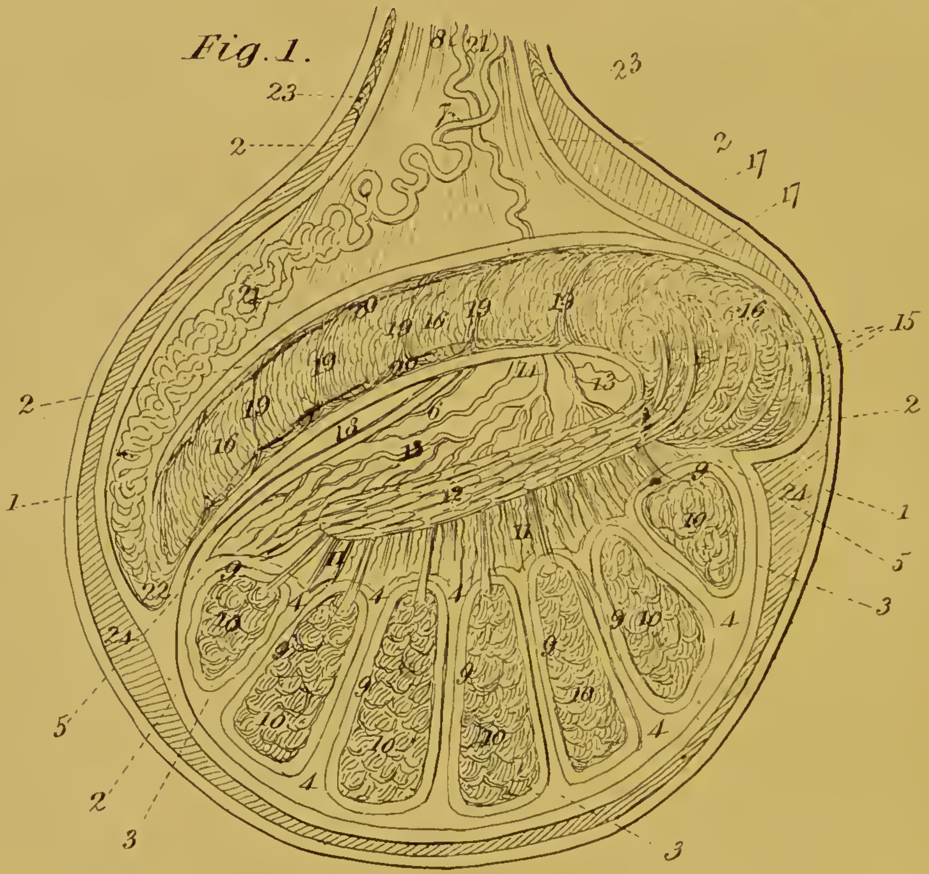

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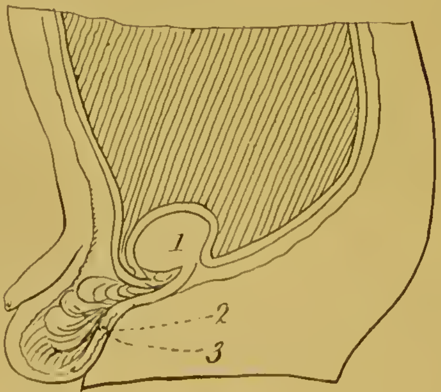

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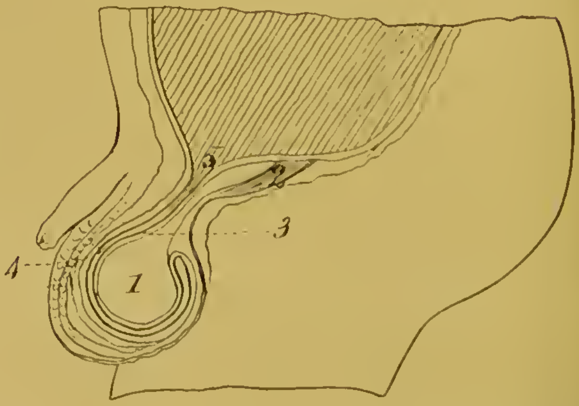

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PLATE II.

Fig. 1.

A diagram of the structure of the testicle.

1. 1. Tunica vaginalis reflexa.

2. 2. 2. 2. 2. Tunica vaginalis testis.

3. 3. 3. Tunica albuginea.

4. 4. 4. 4. 4. 4. Ligamentous bands given off from the mediastinum, and dividing the glandular structure into lobes.

5. 5. The part where the tunica albuginea splits to enclose the corpus highmorianum, mediastinum, rete, and the entrance of the vessels.

6. The tunica albuginea passing to be lost in the cord.

7. The spermatic cord.

8. The spermatic artery taking a tortuous course to be lost in the tunica vasculosa.

9. 9. 9. 9. 9. 9. 9. 9. 9. The tunica vasculosa, lining the tunica albuginea, and from thence giving off minuter distributions to the lobes, lobules, and tubuli seminiferi.

10. 10. 10. 10. 10. 10. 10. Lobes and lobules of the tubuli seminiferi.

11. 11. The mediastinum enclosing the tubuli, which pass through it to form the rete.

12. The rete passing in a direction corresponding with the long axis of the testis.

13. 13. The corpus highmorianum, above and behind the rete, enclosing the vessels entering the testis from the spermatic cord.

14. The vessels entering from the cord.

15. The vasa efferentia.

16. 16. 16. The epididymis.

17. 17. The tunica vaginalis testis enclosing the epididymis, and uniting the caput and cauda to the testis more closely than its body.

18. The part less closely united than the cauda and caput.

19. 19. 19. 19. 19. Ligamentous bands crossing the epididymis from the back to the fore part, and dividing it into lobes.

20. 20. Ligamentous bands passing along the convex and concave edges of the epididymis in the direction of its long axis.

21. 21. The vas deferens.
22. Sudden duplicature of seminal tube at the junction of the vas deferens and cauda epididymis.
23. Union by adhesion which takes place between the close and reflected portions of the tunica vaginalis.
24. Serous cavity of the tunica vaginalis.

Fig. 2.

A diagram of the testis in the abdomen, previous to its descent into the scrotum.

1. 1. Double line denoting the reflection of the peritoneum.
2. The kidney.
3. The testis behind the peritoneum.
4. The gubernaculum.
5. The cremaster.
6. The termination of the cremaster in the scrotum.
7. The pouch formed in the peritoneum which receives the testis.
8. Cavity of the peritoneum.

Fig. 3.

Second diagram of the descent of the testis.

1. Testis descended to the brim of the pelvis.
2. Cremaster drawn down in folds.
3. Gubernaculum shortened and absorbed.

Fig. 4.

Third diagram of the descent of the testis.

1. The testis drawn into the pouch of peritoneum, above the rings, which corresponds to 7. fig. 2.; and which pouch descends with the testis into the scrotum.
2. The gubernaculum shortened.
3. The cremaster, as it descends, drawn into more numerous folds.

Fig. 5.

Diagram of the descended testis.

1. The testis suspended by the spermatic cord and cremaster.
2. The cremaster muscle.
3. Tunica vaginalis testis.
4. Tunica vaginalis reflexa.
5. The communication between the cavity of the peritoneum and tunica vaginalis, which afterwards closes by adhesion.

PLATE III.

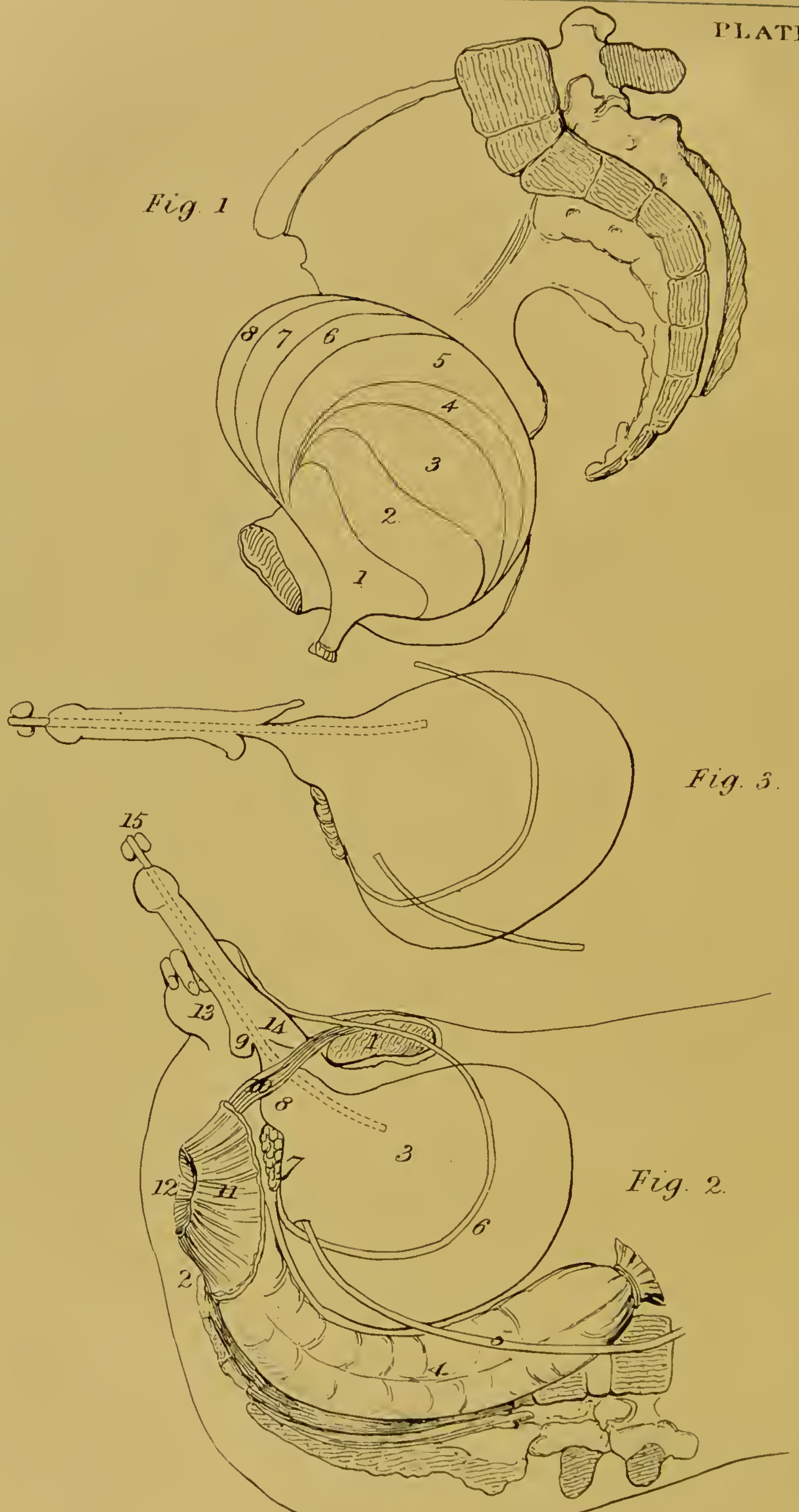

Fig. 1

Fig. 3.

Fig. 2.

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PLATE III.

Fig. 1.

A diagram of the progressive distention of the bladder—the pelvis in the position of the erect posture of the body.

1. Bladder in an empty state.
2. 3. 4. 5. The progress of ordinary distention.
6. 7. 8. The progress of extreme distention.

Fig. 2.

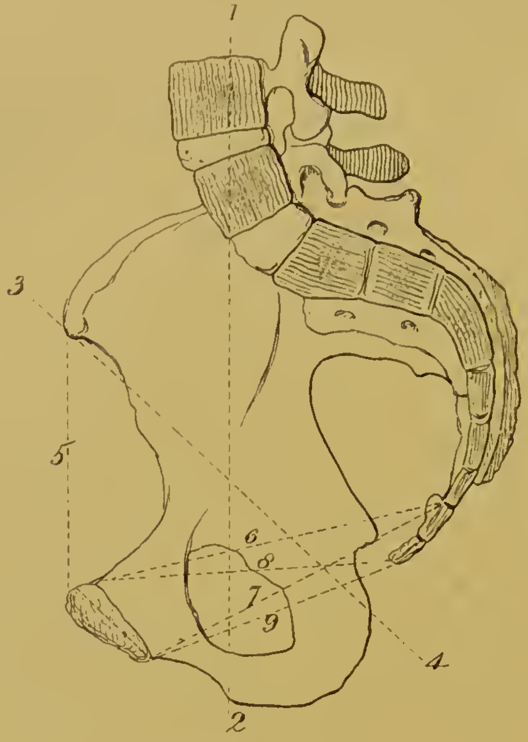
Diagram of the side-view of the pelvis in the erect posture of the body.

1. Symphisis pubis.
2. Extremity of the os coccygis.
3. Bladder.
4. Rectum.
5. Ureter.
6. Vas deferens.
7. Vesiculæ seminales.
8. Prostate.
9. Bulb.
10. Wilson's Muscle.
11. Portion of levator ani.
12. Anus.
13. Scrotum held aside.
14. Crura.
15. Sound—the course it takes marked by dotted lines.

Fig. 3.

Diagram of the bladder in the same position as in fig. 2., to show the course of the sound, when taken from the assistant by the operator, and the consequent elevation of the prostate from the rectum.

PLATE IV.



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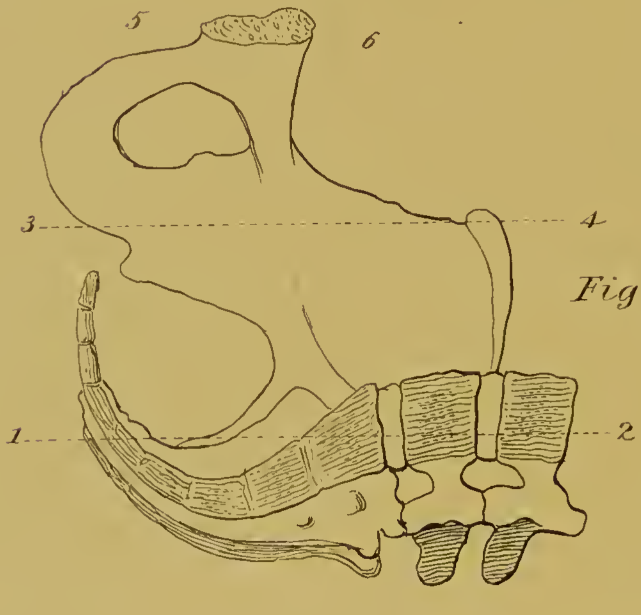

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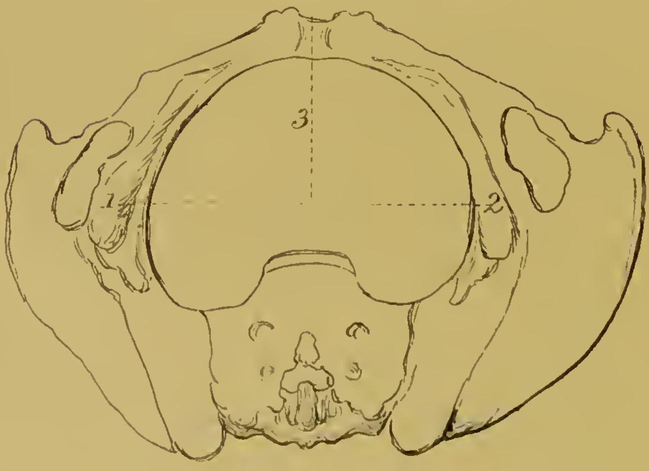

Fig 3.

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PLATE IV.

Fig. 1.

Diagram of the dimensions of the pelvis in the erect posture.

1. to 2. Perpendicular line of the spinal column.
3. to 4. The antero posterior axis of the pelvis.
1. 3. Acute angle made by the axis of the pelvis with the perpendicular line of the spine, at the upper outlet.
1. 4. Obtuse angle of the axis of the pelvis with the perpendicular of the spine, at the lower outlet of the pelvis.
5. Perpendicular line from the anterior superior spinous process of the ilium to the symphisis pubis.
6. Distance of the lower end of the sacrum to the symphisis pubis, 5 inches and a half.
7. Ditto to the arch of the pubis, 4 inches 6-8ths.
8. Distance from the end of the os coccygis to the symphisis pubis, 5 inches.
9. Ditto to the arch of the pubis, 3 inches 6-8th.

Fig. 2.

Diagram of the position of the pelvis in the operation of lithotomy, side-view.

1. to 2. An horizontal line corresponding to 1. 2. in fig. 1.
3. to 4. The axis of the pelvis now brought nearly parallel with the horizontal line of the spine, which must vary in proportion to the degree of mobility between the vertebræ of each individual.
5. to 6. Axis of the symphisis pubis, parallel with the axis of the pelvis.

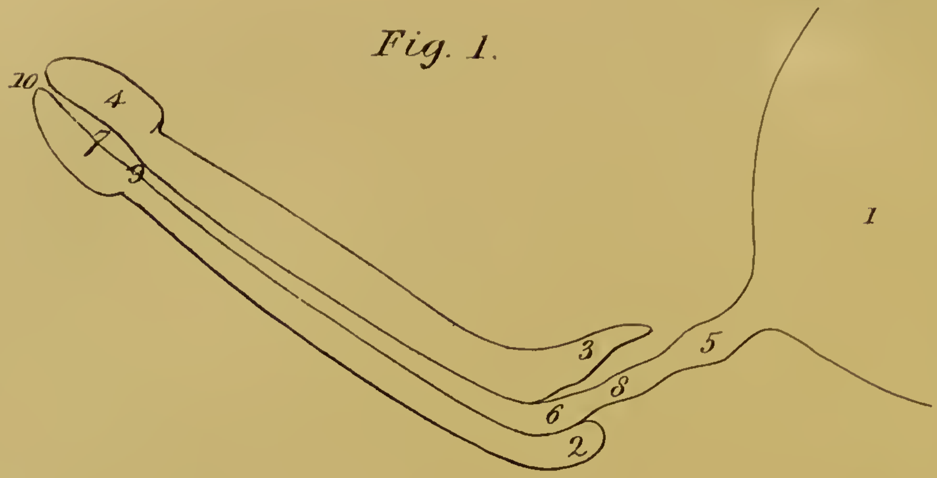
Fig. 3.

Diagram of the lower outlet of the pelvis, front view.

1. to 2. A line drawn from one tuberosity of the ischium to the other.
3. A perpendicular line from the arch of the pubis to the middle of the line 1. 2., which marks the precise situation of the raphe of the perineum.

PLATE V.

Fig. 1.



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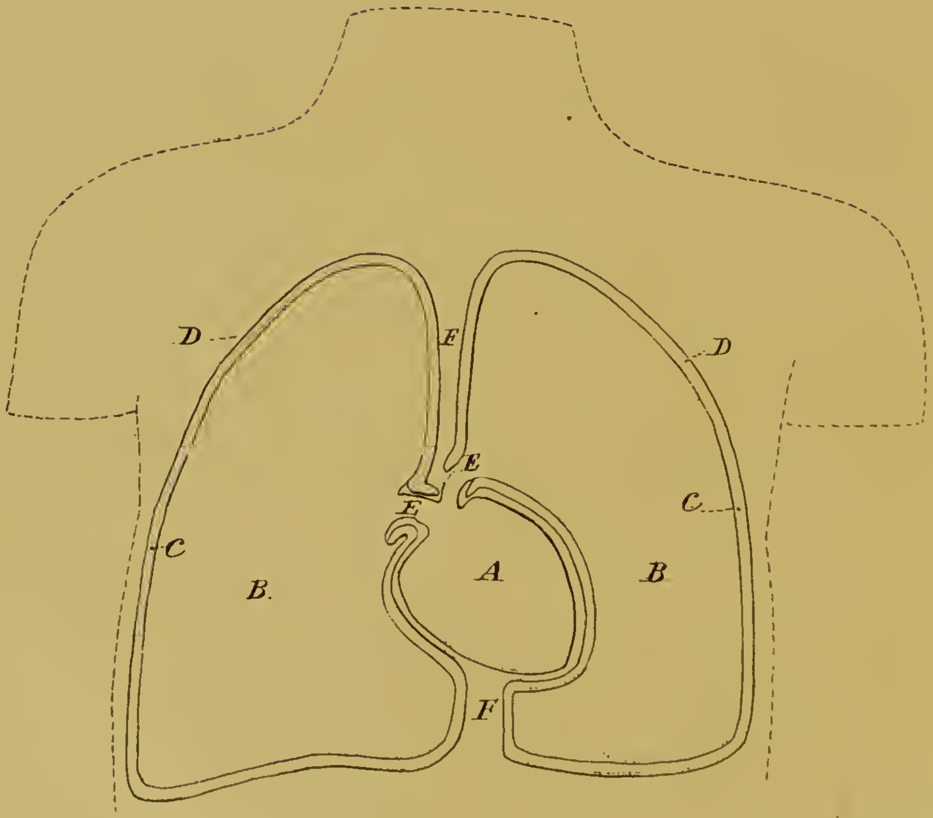

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PLATE V.

Fig. 1.

Diagram of the urethra, to show its contractions and dilatations.

1. The bladder.
2. The bulb of the urethra.
3. The crus penis.
4. The glans.
5. The prostatic enlargement of the urethra.
6. Enlargement in the bulb, termed the sinus Morgagni.
7. Enlargement in the glans, called the fossa navicularis.
8. Contraction in the membranous portion.
9. Contraction at the commencement of the glans.
10. Contraction at the termination of the glans.

Fig. 2.

Diagram of the reflections of the pleuræ.

A. The Heart, covered by pericardium.
B. B. The Lungs.
C. C. Pleuræ pulmonales.
D. D. Pleuræ costales.
E. E. Roots of the lungs, or entrance of the vessels.
F. F. Mediastina.

LECTURES

ON

ANATOMY.

LECTURES

ON

ANATOMY:

INTERSPERSED WITH PRACTICAL REMARKS.

VOL. IV.

By B. B. COOPER, F.R.S.,

SURGEON OF GUY'S HOSPITAL, LECTURER ON ANATOMY,
&c. &c. &c.

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PREFACE.

In offering this my Fourth and last Volume to the Public, I complete the series of my Anatomical Lectures; and trust that I have fulfilled the intentions which I proposed in the Preface to my First Volume.

From the very flattering manner in which the preceding Three Volumes have been reviewed by the periodical press, and from the readiness with which the pupils, not only of my own, but of other classes, have adopted my general classification and mode of anatomical instruction as their guide, I cannot but indulge a sanguine expectation, that the Work may be found useful, not only to the Student, but to the Profession at large.

New Street;
October, 1832.

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PART VII.

DESCRIPTIVE ANATOMY OF THE ARTERIES.

LECTURE XXVI.

DESCRIPTIVE ANATOMY OF THE ARTERIES.

The principle which I have adopted in the following description of the arteries, I have taken from the example of my friend Mr. Joshua Brookes, as it possesses considerable advantage in assisting the memory of the student.

It is to consider the two principal arteries arising from the heart, as arterial trunks. The branches immediately given off from the systemic trunk, are named arteries, and numbered in the order of their succession. The branches from arteries, are named rami; branches from rami, ramuli; branches from ramuli, ramusculi; branches from ramusculi, ramifications; and their ultimate terminations, distributions.

Before we commence a description of the anatomy of the arteries, it will be necessary again to take a view of the precise situation of the heart within the thorax, in order that its position in relation to the large arteries arising from it may be clearly understood.

The heart is placed obliquely within the chest; its base being opposite to the fourth dorsal vertebra, partly resting upon the diaphragm; while its apex is directed obliquely downwards, forwards, and to the left, towards the interspace of the fifth and sixth ribs. With regard to the ventricles and auricles,—those of the right side are placed most anteriorly, and form the acute edge; while the left auricle and ventricle form the obtuse edge, and posterior part of the heart.

The PULMONARY ARTERIAL TRUNK—already described with the organization of the lungs (*Vide* Vol. III. p. 186), is the first vessel seen in the natural position of the heart; arising from the upper and anterior part of the base of the right ventricle, where it conceals the origin of the aorta.

The AORTA—the main trunk of the systemic distribution, arises from the base of the left ventricle, and immediately takes its course obliquely upwards, and to the right; and, like the pulmonary, appears to be directed, so as to convey the current of the blood in the direction of the contractile forces of their respective ventricles.

The origin of the aorta is opposite to the fourth dorsal vertebra, its termination at the junction of the fourth with the fifth lumbar vertebra; in this extent it takes a curved course, and is divided into an ascending, transverse, and descending portion.

The ASCENDING AORTA—commences from the upper and fore part of the left ventricle, rather to the left of the fourth dorsal vertebra, and extends upwards and obliquely to the right, in the direction of the long axis of the heart, as high as the upper edge of the third dorsal vertebra, where it terminates in the commencement of the arch. In this course it is first covered by the pulmonary artery, which arises immediately in front of it; above which is a small space, still within the pericardium; on emerging from the pericardium, it takes its course between the pulmonary artery on the left, and the superior cava on the right; while the right branch of the pulmonary artery is behind it. This portion of the aorta is visible on opening the cavity of the chest, having nothing in front of it, excepting the contents of the anterior mediastinum, which separates it from the second bone of the sternum. The aorta is connected with the heart in the following manner:—Externally, by a continuation of the pericardium; secondly, by its fibrous coat, which is not a continuation of the muscular fibres of the heart, but commences abruptly by three semilunar folds, which are attached to the fleshy fibres of the ventricle; thirdly, by the internal lining membrane of the ventricle, which is continued into the ascending aorta, forming at its commencement three semilunar valves. The opening of the aorta from the ventricle is of a triangular figure, and contracted, but almost immediately enlarges, forming three pouches corresponding to each valve, which are termed the sinuses of Morgagni. These pouches are not produced by the pressure of the column of regurgitating blood, but are natural formations tending to facilitate the propulsion of the blood in the systole of the heart, being surrounded by the muscular fibres of the ventricle itself, which partly overlap them where they are exterior to the semilunar valves.

The only branches which are given off by the ascending aorta are, the coronary or cardiac arteries, whose office it is to supply the heart itself with blood. They are two in number, and are distinguished from each other by their course.

(1.) *Arteria coronaria dextra vel anterior* — is sent off from the ascending aorta, immediately above the free edge of the semilunar valve, which faces somewhat diagonally towards the right side. It immediately after its origin takes its course downwards and forwards, in front of that portion of the aorta which is seen anteriorly before it is crossed by the pulmonary arterial trunk; it then passes in a tortuous manner in the fissure between the right auricle and ventricle, where it divides itself into three principal rami, —a superior, an inferior, and a posterior.

(A.) *Ramus superior*—passes in a course between the auricle and ventricle, along the base of the latter, around which it passes until it meets a similar branch from the left coronary artery. In this course it distributes several ramifications, some of which pass upward and backward to the right auricle, and others downward and forward to the parietes of the right ventricle.

(B.) *Ramus inferior*—is directed forwards and downwards, along the thin edge of the right ventricle, as far as the apex of the heart, where it anastomoses with the left coronary artery, dividing in its passage into several anterior and posterior ramifications, to supply the corresponding surfaces of the ventricles and septum cordis.

(C.) *Ramus posterior* — passes backwards and downwards to supply the back part of the right ventricle and septum cordis, and anastomoses, like the inferior branch, at the apex.

(2.) *Arteria coronaria sinistra vel posterior*—is smaller than the right, it arises immediately above the floating edge of the most anterior of the semilunar valves; but, like the right, is placed rather transversely, being inclined to the left, to take its course between the pulmonary artery and left auricle, by the apex of which it is partly concealed. It soon divides into two rami, a superior and an inferior.

(A.) *Ramus superior*—takes its course backwards, in the groove between the left auricle and ventricle, sending off numerous ramifications superiorly and inferiorly to supply each of these cavities, and terminates by anastomosing with the superior branch of the right coronary artery. By this anastomosis, the arteries form a complete line of separation between the auricles and ventricles.

(B.) *Ramus inferior*—descending along the septum cordis anteriorly, sends numerous ramifications into the substance of both ventricles, as well as to the fleshy partition between them; and terminates at the apex, by freely anastomosing with the right coronary artery.

The ultimate termination of the coronary arteries may be considered to be in the fleshy fasciculi of the heart; but they also frequently anastomose with the phrenic, internal mammary, and bronchial vessels.

At the third dorsal vertebra, where it has already been said that the ascending aorta terminates, there the *arch* of that vessel begins,—which has now to be described.

The ARCH OF THE AORTA—extends from the right of the upper part of the third dorsal, to the left of the same bone; in its course it first passes upwards, backwards, and to the left, as high as the second dorsal vertebra, which it crosses, being placed in front of the trachea; where, having gained its vertex, it is continued downwards and backwards, between the vertebræ and left lung, to arrive at the left side of the third dorsal vertebra, where the arch is completed. It is to be observed, therefore, that the arch is not placed transversely, but is directed from before to behind, from right to left, and from above to below. To facilitate a more accurate description of the relative position of the arch of the aorta, it may be divided into its right anterior, its middle, and its left posterior thirds.

The *right anterior third of the arch*—is that portion between the ascending aorta and the arteria innominata.

The *middle third*—where it crosses the second dorsal vertebra, resting upon the trachea just above its division ; and

The *left posterior third*—where it reaches from the left of the second to the lower edge of the third dorsal vertebra.

Each of these parts has some important anatomical points connected with it.

The right anterior third, instead of continuing in the direction of the ascending aorta, namely, in that of the axis of the heart, is directed backwards and to the left; it passes in front of the right bronchus, is placed between the trachea and descending vena cava, and has connected with it the left vena innominata, which is just above it. It is about opposite to the junction of the cartilage of the second rib with the first two bones of the sternum.

The middle third, as has been before said, rests upon the trachea, opposite the second dorsal vertebra. It may be comprehended between the arteria innominata and the left subclavian ; the left vena innominata runs immediately above it; and just where the middle becomes connected with the descending portion of the arch, the ductus arteriosus connects it with the pulmonary arterial trunk.

The inferior third, as it lies upon the left side of the bodies of the second and third dorsal vertebræ, which are frequently indented by the pressure of this vessel, has, to the right, the œsophagus, and more posteriorly, the thoracic duct ; while immediately behind it, is the recurrent laryngeal branch of the par vagum—the par vagum being placed in front. The concavity of the arch of the aorta is directed downwards and to the left; and within its parabolic curve it encloses several important organs: first is seen the pulmonary trunk, and its two arteries; behind them, the left bronchus, the œsophagus, the thoracic duct, and the left pneumogastric nerve, with its recurrent branch, besides some small dark coloured glands surrounding the bronchi.

The arteries given off from the convexity of the middle third of the arch of the aorta are usually three in number, and are destined to supply the neck, head, upper extremities, and part of the chest.

These are denominated the arteria innominata, the left carotid, and the left subclavian arteries.

(3.) *Arteria innominata*—arises from the junction of the anterior with the middle third of the arch, being, therefore, from the most anterior portion of the aorta, and opposite to the junction of the cartilage of the second rib to the sternum; from thence it extends upwards, obliquely, to the right, as high as the sterno clavicular articulation, where it divides into the right common carotid and right subclavian vessels.

In this course the arteria innominata is bounded in *front* by the sternum, sterno hyoideus and sterno thyroideus muscles, and vena innominata; *behind*, by the trachea and longus colli muscle; the latter, however, is separated from the vessel by a considerable quantity of cellular membrane.

The arteria innominata, from its commencement to its division, does not usually give off any branches; but sometimes a small vessel arises from it, which passes upwards, in front of the trachea, to be distributed to the thyroid gland, and has been described as the middle thyroid artery.

The origin of the left common carotid artery should next be examined, as it arises within the thorax from the arch of the aorta; and is not placed under the same circumstances as the right until it has reached the left sterno clavicular articulation; the point corresponding with the commencement of the right common carotid.

(4.) The *arteria carotidis communis sinistra*—arises from the arch of the aorta, on a plane posterior to the arteria innominata, and forms very nearly a right angle with the arch, passing upwards, with a slight obliquity to the left, as high as the sterno clavicular articulation, where it is placed under precisely the same circumstances as the right carotid. By the extent of its thoracic portion it is longer than the right, but is somewhat smaller; and, in this situation, is bounded in front by the sternum, by the remains of the thymus gland, and crossed by the vena innominata: it runs upwards on the left side of the trachea, to which it is nearly parallel, but partly covers it, as well as the thoracic duct and œsophagus; then emerging from the chest, it corresponds to the right vessel: from hence, therefore, one description answers for both arteries.

(4.) The *arteriæ carotides communes*—from the sterno clavicular articulations, diverge, as they pass upwards and backwards, to reach the upper edge of the thyroid cartilage, where they each divide into an external and an internal corotid ramus. This division most frequently takes place on a plane with the lower edge of the third cervical vertebra. In this course they are placed under different circumstances as regards their relative position with neighbouring parts, being at their commencement deeply seated, covered by the platysma myoides, sterno cleido mastoideus, sterno hyoideus, sterno thyroideus, and omo hyoideus muscles; but when they reach as high as the cricoid cartilage they become superficial, in consequence of the direction the sterno cleido mastoidei muscles take upwards and backwards to gain their insertion; so that from this point to their termination, the common carotid arteries are lying in a hollow between the inner edge of the sterno cleido mastoidei and larynx, and are only covered by the platysma myoides, fascia of the neck, and superficial veins and nerves.

At their commencement, the common carotids correspond posteriorly to the bodies of the cervical vertebræ; but above, to their transverse processes: they first rest upon the longus colli muscle, and as they ascend, upon the rectus capitis anticus major; they each cross in front of the inferior thyroideal ramulus, the recurrent branch of the par vagum and the sympathetic nerve. The common carotid arteries are enclosed in a sheath of fascia, and are accompanied by the internal jugular vein, which is on their outer side, and by the pneumogastric nerve, which runs between the artery and vein. Exterior to the sheath, and in front, the descending branch of the lingual nerve may be seen, being placed to its outer or mastoid side above, and to its inner or tracheal side below; forming, in this course, junctions with the cervical nerves.

The common carotid arteries, as has been before mentioned, diverge, as they pass from below upwards, to an extent depending more or less upon the size of the trachea and larynx; they do not give off any branches prior to their division into an external and internal carotid, opposite to the upper edge of the thyroid cartilage.

I shall now, contrary to the plan usually followed by anatomical writers, describe that portion of the left subclavian artery which is placed within the cavity of the chest, instead of first tracing the numerous ramuli of the external and internal carotids, as I shall then have completed the account of the origin of the vessels from the arch of the aorta

(5.) *Arteria subclavia sinistra*—like the left common carotid, arises from the arch of the aorta, within the thorax, but posterior to it, being separated from the arch just at the junction of the middle with the descending third; from this point it ascends, nearly vertically, as high as the inner edge of the first rib, where it is placed under the same circumstances as the right subclavian; and from thence a common description will serve for both vessels.

While this vessel is within the chest it is very deeply seated, resting upon the longus colli muscle and inferior cervical ganglion of the sympathetic nerve, running upwards parallel with the œsophagus; it is, anteriorly, covered by the left lung and pleura, the par vagum, the left common carotid artery, the jugular vein and vena innominata, the thoracic duct, the sterno cleido mastoideus, sterno hyoideus, sterno thyroideus muscles; and as to bones, by the first rib, clavicle, and sternum. This portion of the left subclavian artery, which renders it so much longer than the right, is, however, the smaller; and is much more deeply seated than it, the arteria innominata, or the left common carotid.

The common carotid arteries have already been described as passing from their origin to the upper part of the thyroid cartilage, before they divide; and in this course they do not give off any branches, but terminate by dividing into an external and an internal carotid ramus, which are destined to supply the head, face, and neck.

(A.) *Ramus carotidis externus* — supplies the face and exterior of the head. It extends from the upper edge of the thyroid cartilage to the cervix of the lower jaw, where it terminates by dividing into the temporal and internal maxillary ramuli, within the substance of the parotid gland. In its course it is at first anterior, and to the inner side of the internal carotid, and runs parallel to it, in this situation being comparatively superficial; it then dips under the lingual nerve, the stylo hyoideus muscle, and at the posterior belly of the digastricus again becomes superficial, here as below being only covered by the platysma myoides; it then passes outwards and backwards, just behind the angle of the lower jaw, where it buries itself in the substance of the parotid gland, to divide into the temporal and internal maxillary ramuli. In thus passing to its termination it does not take a straight course, but presents a convexity, looking forwards and upwards toward the pharynx and tonsil, and a concavity backward, to the sterno cleido mastoideus.

It has opposed to it on its inner side the pharyngeal plexus of nerves, the stylo glossus, stylo pharyngeus muscles, and glosso pharyngeal nerve; and above, a portion of the parotid gland; all of which tend to separate the external from the internal carotid artery.

The ramuli which this ramus distributes may be divided into four distinct sets, from the direction of their course, viz.:—anteriorly, posteriorly, internally, and ascending.

The anterior ramuli of the external carotid, which are given off from the convexity of its curve, may now be examined: they are three in number,—the superior thyroideal, the lingual, and the facial.

(*a.*) *Ramulus thyroideus superior vel descendens*—is the first vessel sent off by the external carotid, and usually immediately below the cornu of the os hyoides; it extends to the thyroid gland, in which it ramifies, taking however a circuitous course, first running upwards and inwards, and then forming its course downwards to the thyroid gland. The trunk of this vessel is only covered by the platysma myoides, being accompanied by the laryngeal nerve, which is posterior to it; while above, but separated from it by the cornu of the os hyoides, is the lingual ramulus and nerve.

The superior thyroideal ramulus is destined to supply parts between the os hyoides and thyroid cartilage, the larynx and the thyroid; for which purpose, it sends off three principal ramusculi—ramusculus hyoideus, ramusculus laryngeus, and ramusculus thyroideus.

(*α.*) *Ramusculus hyoideus*—ascends from the trunk of the thyroid ramulus, and usually takes its course along the under edge of the os hyoides, anastomosing with a similar vessel of the opposite side, sending ramifications upwards to anastomose with the lingual ramulus, and to supply the thyro hyoideus, omo, and sterno hyoidei muscles, and the thyro hyoid ligament.

A superficial ramification is usually separated from the hyoideal, which runs downwards to supply the glands of the neck, sterno cleido mastoideus, and platysma myoides.

(*β.*) *Ramusculus laryngeus*—proceeds towards the upper part of the larynx, behind the thyro hyoideus muscle, accompanied by the laryngeal branch of the par vagum. This little ramusculus enters the larynx, sometimes above the thyroid cartilage, piercing the broad ligament; at others between the thyroid and cricoid, penetrating the crico thyroid ligament; and less frequently, passes through a foramen of the thyroid cartilage: when it has gained the interior, it divides into numerous distributions to supply the muscles and mucous membrane of the larynx and epiglottis, anastomosing with those of the opposite side. A small ramification should be particularly observed, which takes its course downwards and inwards over the thyroid cartilage to gain the crico thyroid ligament, where it forms an anastomosis with a similar ramification of the opposite side. This vessel should be particularly remembered in opening the larynx between these two cartilages.

(γ.) *Ramusculus thyroideus*—seems a continuation of the original ramulus, and takes its course behind the sterno thyroideus muscle to gain the thyroid gland, where it divides pretty generally into three ramifications: one, running along the upper edge of the gland to anastomose with its fellow; a second, passing behind the gland, between it and the trachea; and a third, taking its course downwards, along the outer edge of the gland, to anastomose with the inferior thyroideal ramulus—but all plentifully supplying the parenchyma of the organ.

Although the lingual ramulus is the next given off by the external carotid, it is better first to dissect the fascial and its ramifications, as the lingual may be more readily dissected afterwards.

(*b.*) *Ramulus maxillaris, vel facialis externus*—is usually given off by the external carotid, behind the digastricus and stylo hyoideus muscles; it immediately takes a tortuous course forwards and inwards, towards the submaxillary gland, behind which it passes (the gland usually separating this artery from its accompanying vein); it then runs forwards upon the mylo hyoideus muscle, from the anterior edge of which it dips down to pass around the horizontal portion of the lower jaw to gain the face, just anterior to the edge of the masseter muscle, being covered by the platysma myoides, and some fibres of the depressor anguli oris; here it becomes embedded in a considerable quantity of fat, lying on the buccinator muscle. It then winds under the zygomatici, and levator labii superioris alæque nasi muscles; and running up by the side of the nose, terminates at the inner canthus of the eye, anastomosing with the nasal ramusculus of the ophthalmic of the internal carotid.

In this course it gives off numerous ramusculi, which may be divided into two sets,—those which are given off below the jaw, and those which are distributed to the face.

Those which are given off below the jaw, are two principal ramusculi,—the inferior or ascending palatine, and the submental, besides some small ramifications to the muscles and glands.

(α.) *Ramusculus palati inferior, vel ascendens*—is given off almost immediately, at the separation of the facial from the external carotid; it then passes upwards, in front of the stylo pharyngeus and behind the stylo glossus muscle, upon the side of the pharynx, and distributes itself to these muscles, to the tongue, the tonsils, and the eustachian tube; and is lost by supplying the soft palate and uvula, anastomosing with the superior or descending palatine ramusculus of the internal maxillary ramulus.

Muscular ramifications—are sent off below the jaw to the stylo hyoideus, stylo pharyngeus, and stylo glossus muscles.

(β.) *Ramusculus tonsilaris*—near the insertion of the stylo glossus, is often separated from the facial ramulus; and penetrating the pharynx, supplies the tonsil of its own side.

(γ.) *Ramusculi glandulares*—are also distributed from this vessel to the submaxillary gland, and neighbouring absorbent glands.

(δ.) *Ramusculus submentalis*—is separated from the facial artery while it is covered by the submaxillary gland, and proceeds forwards, above the anterior belly of the digastricus, towards the symphisis of the lower jaw, being placed superior to the lower edge of the horizontal portion, resting upon the mylo hyoideus, and surrounded by a chain of absorbent glands. This ramusculus not unfrequently supplies the place of the sublingual of the lingual ramulus. It distributes ramifications downwards and in front of the digastricus, to anastomose with a corresponding ramification from the opposite side; sending some downward, to anastomose with the hyoideal ramusculi of the lingual ramulus; and some upward upon the chin, to anastomose with the dental of the internal maxillary, and inferior labial of the facial—supplying at the same time various muscles.

After having distributed these vessels below the jaw, the ramulus facialis mounts upon the face, and distributes the following ramusculi—first externally.

(ε.) *Ramusculi masseteres*—which supply the masseter muscle; and some take their course with the parotid duct, and supply the gland, anastomosing with the ramusculi of the temporal.

Ramifications are also distributed to the buccinator, to the platysma myoides, and to the depressor labii inferiores; anastomosing with the submental ramusculi, and the inferior dental as it passes out of the anterior maxillary foramen.

(ζ.) *Ramusculus labialis inferior*—takes a very tortuous course towards the commissure of the mouth, and supplies both the muscles and mucous membrane of the under lip; anastomosing with the corresponding ramusculus of the opposite side, and also with the inferior dental and submental ramusculi.

(η.) *Ramusculus labialis superior vel coronarius*—is given off from the ramulus facialis, above the commissure of the mouth, and gains by a very tortuous course the upper lip, into the muscles and mucous membrane of which it plentifully distributes itself, anastomosing in the centre of the lip with the opposite corresponding ramusculus, from which small ramifications mount vertically towards the partition of the nose, where they expand themselves, supplying the depressor muscles of the lip and alæ of the nose.

The coronary ramusculi are, however, very variable, both as to situation and size. One of them very frequently extends to the commissure of the mouth, and there dividing, supplies the place of both.

The facial ramulus is still continued upwards by the side of the nose, under the levator labii superioris alæque nasi, and in its course sends off the

(ϑ.) *Ramusculus lateralis nasi*—which distributes itself upon the side of the nose, supplying the compressor nasis, anastomosing with its fellow and descending ramification from the forehead.

The facial ramulus terminates by giving off the

(ι.) *Ramusculus angularis*—which mounts to the inner canthus of the eye, between the two origins of the levator labii superioris alæque nasi, where it anastomoses with the infra orbitar ramusculus of the internal maxillary, sending ramifications in this situation to the orbicularis palbebrarum; it then reaches the lachrymal sac, which it supplies, anastomosing here with the nasal ramusculus of the ophthalmic of the internal carotid, and terminates by ramifications to the orbicular muscle of the upper eye-lid, and by anastomosing with the supra orbitar ramusculus of the internal carotid ramus.

(*c.*) *Ramulus lingualis.*—This vessel is not unfrequently given off from the external carotid, in a common trunk with the facial, but more frequently below it, and between it and the superior thyroideal. It is rather more deeply seated, and takes its course forwards, upwards and inwards, above the os hyoides, to gain the tongue. In the first part of its course it is accompanied by the lingual nerve, which is rather above it; and until it gains the posterior edge of the hyo glossus muscle, it is only covered by the skin, platysma myoides, and fascia; it then passes above the hyo glossus muscle, by which it is separated from the lingual nerve, which takes its course upon the inferior surface of the muscle, at the anterior edge of which they again meet, and between the hyo glossus and genio hyo glossus terminate in the tongue.

In this course, the lingual ramulus gives off the four following ramusculi.

(α.) *Ramusculus hyoideus*—is given off before the lingual ramus gains the upper surface of the hyo glossus muscle;

this ramusculus passes along the superior surface of the os hyoides, distributing itself to the muscles of the base of the tongue, and of the lower jaw.

(β.) *Ramusculus dorsalis linguæ*—is given off from the lingual while upon the upper surface of the hyo-glossus; it takes its course upwards and outwards, towards the base of the tongue; and passing between the hyo-glossus and lingualis muscles, it gains the dorsum of the tongue, where it anastomoses with the opposite ramusculus, sending ramifications backwards to supply the fauces, tonsil, and epiglottis, anastomosing with the ascending palatine ramusculus of the facial ramulus.

(γ.) *Ramusculus sublingualis*—is frequently substituted by the submental ramulus of the facial; when given off by the lingual it arises just at the anterior edge of the hyo-glossus muscle, and takes its course forwards between the genio-hyoideus muscles, and the sublingual gland,—supplying both; it then penetrates the mylo-hyoideus, and is lost upon the chin, anastomosing with the submental, the inferior dental, and the inferior coronary ramusculi.

(δ.) *Ramusculus raninus*—seems to be a continuation of the lingual ramus, and is continued forwards to the apex of the tongue, between the lingualis and genio-hyo-glossus muscles, distributing a ramification to them, and also to the hyo-glossus and stylo-glossus muscles, as well as to the frænum, by the side of which it runs, being there only covered by the mucous membrane of the tongue, and accompanied by a vein and a branch of the lingual nerve.

The ramuli given off from the external carotid artery, posteriorly, are the occipital and posterior aural.

(*d.*) *Ramulus occipitalis*—is usually separated from the external carotid, opposite to the origin of the facial or lingual ramulus, but is smaller than either of them; it extends to the posterior part of the occipital bone, where it terminates by numerous anastomosing vessels. In taking this course, it passes backwards under the posterior belly of the digastricus, sterno cleido mastoideus, trachelo mastoideus muscles, and the lingual nerve, which completely hooks around it; it crosses anterior to the internal carotid artery, jugular vein, pneumo-gastric, and spinal accessory nerves, and then rests upon the rectus capitis lateralis, being placed between the transverse process of the atlas and the occiput, being here covered by the splenius, and complexus, the latter of which muscles it frequently perforates to gain the occiput, immediately above the attachment of the obliquus superior and rectus capitis posticus major. The first ramusculi sent off from the occipital ramulus, supply the digastric and stylo-hyoideus muscles.

Ramuli also pass downward along the anterior edge of the sterno cleido mastoideus, to supply the superficial cervical glands, and terminate by anastomosing with the superior thyroideal ramusculi.

While the occipital ramulus is crossing the carotid artery and internal jugular vein, it sends a ramusculus meningeus upwards on the vein which passes through the foramen lacerum basis cranii, to supply the dura mater. It also sends the ramusculus auricularis to the lobe of the ear; and when behind the trachelo mastoideus, and splenius, it supplies them both with blood. When it gains the occiput, it sends a ramification transversely above the insertion of the obliquus, and rectus superior muscles, to anastomose with the corresponding vessel of the opposite side, forming an arch, with its convexity upwards and concavity downwards; from the latter, several ramifications pass downward to supply the recti and obliqui.

A deep ramification passes to anastomose with the vertebral artery; and a long descending ramification passes upon the semispinalis colli and under surface of the complexus, to anastomose with the ramus cervicalis profundus of the subclavian artery. From the convexity, numerous ramifications pass upward on the occiput to anastomose with the temporal and posterior aural, one of which passes through the mastoid foramen to supply the dura mater.

(*e.*) *Ramulus auricularis posterior, vel stylo-mastoideus*—

is given off in the substance of the parotid gland, above the posterior belly of the digastric muscle, and in front of the styloid process of the temporal bone; it takes its course backwards, towards the mastoid process of the temporal bone, between it and the ear; it ascends upon the bone, anastomosing with the temporal and occipital ramusculi. In this course it sends off small ramifications to the parotid gland, the digastric, sterno cleido mastoideus, and trapezius muscles.

(α.) *Ramusculus stylo mastoideus*—passes into the stylo mastoid foramen, and also divides into numerous smaller ramifications to supply the ear.

(β.) A ramusculus passes to the tympanum, which runs around the bony circumference of the membrana tympani; and anastomosing with a branch from the internal maxillary, they send off distributions to supply the membrane.

Ramifications also supply the mastoid cells, the cavity of the tympanum, and the canal of fallopius.

The posterior aural, after having sent off the stylo mastoid ramusculus, distributes ramifications behind the ear to supply the posterior part of the concha, and backwards to ramify on the splenius muscle and occipital bone, anastomosing with the occipital ramulus; and its terminating ramifications pass upward upon the aponeurosis of the temporal muscle to anastomose anteriorly with the temporal, and posteriorly with the occipital ramusculi.

The ramus which is given off from the inner side of the external carotid artery, is the

(*f.*) *Ramulus pharyngis ascendens, vel inferior*—which is a very small vessel, and so deeply situated as to be with difficulty exposed. It arises from the inner side of the external carotid, on a level with the facial ramulus, but posterior to it, and ascends on the rectus capitis anticus muscle, between the external and internal carotids. At first it is placed behind the stylo pharyngeus muscle, and then behind the outer edge of the constrictors of the pharynx. In this course it sends distributions inwards to supply the pharynx, sending a distinct vessel to each constrictor muscle,—the superior one supplying also, by small *outer* ramifications, the stylo pharyngeus muscle, and the eustachian tube,—and *anterior* ones to the soft palate, and internal parts of the nostrils. The trunk of the ascending pharyngeal ramulus still passes upwards, between the internal carotid and jugular vein, to enter the foramen lacerum basis cranii, and terminate on the dura mater.

(α.) *Ramusculus meningeus.*—Some small ramusculi also enter the cranium through the anterior lacerated, and anterior condyloid foramina, to supply the bones of the skull and dura mater. The par vagum, and sympathetic nerves, are also supplied with blood by these ramusculi.

The two ramuli by which the external carotid terminates, are—

(*g.*) *Ramulus temporalis superficialis.*—This ramulus, which seems to be a continuation of the external carotid, passes upwards between the neck of the lower jaw and the auditory canal, being covered by the parotid gland; it then arises above the zygomatic arch, passing under the anterior auricular muscle, becomes superficial, and ramifies upon the aponeurosis of the temporal muscle. In this course it sends off the following ramusculi.

(α.) *Ramusculus parotideus*—to supply the parotid gland.

(β.) *Ramusculus articularis*—to the temporo maxillary articulation, which passes to the posterior part of the meatus auditorius, and sending small ramifications through the glenoid fissure into the cavity of the tympanum, anastomoses with the posterior auricular artery, and supplies the membrana tympani, and the muscles of the malleus.

(γ.) The *ramusculus transversus facialis*—is most frequently given off by the temporal, although sometimes from the external carotid itself. It takes its course with, and above the parotid duct, across the masseter muscle, being surrounded by filaments of the portio dura nerve; having reached the anterior edge of the masseter muscle, it divides into numerous ramifications to anastomose with the alveolar, infra orbitar, and with the coronary distributions of the facial ramus.

(δ.) The *ramusculus profundus temporalis*—is usually sent off below the zygomatic arch, then rises above it to penetrate the aponeurosis of the temporal muscle, to be distributed to it, anastomosing with the deep temporal ramification of the internal maxillary ramulus of the external carotid. The temporal ramulus, immediately after it has given off the last described ramusculus upon the aponeurosis of the temporal muscle, terminates by dividing into an anterior and posterior ramusculus.

(ε.) *Ramusculus temporalis anterior*—takes its course upwards and forwards, towards the upper part of the orbicularis palbebrarum, to be distributed to it, the integuments and muscles of the forehead, anastomosing with the supra orbitalis, and frontal ramifications of the ramulus ophthalmicus of the internal carotid ramus.

(ζ.) *Ramusculus temporalis posterior*—curves upwards and backwards, distributing numerous ramifications to the scalp and occipito frontalis muscle, anastomosing with the posterior auris, and ramulus occipitalis of the external carotid.

(*h.*) *Ramulus maxillaris internus*—the second ramulus forming the termination of the external carotid, is destined to supply the deep-seated parts of the face, and extends from immediately behind the neck of the lower jaw to the spheno-maxillary fossa. In this course it is tortuous, but passes with sufficient regularity of direction as to admit of being described in four distinct portions. The first is horizontal, passing forwards nearly at right angles from the external carotid, between the neck of the lower jaw and internal lateral ligament of the temporo maxillary articulation. While in this situation, two ramusculi are sent off by the internal maxillary ramulus,—one passing upwards to the dura mater, the other downwards to supply the teeth of the lower jaw.

(α.) *Ramusculus meningeus medius vel spheno-spinalis*—arises from the upper part of the internal maxillary ramulus, and passes vertically upwards towards the foramen spinosum of the sphenoid bone, being first placed to the outer side of the internal lateral ligament of the lower jaw; it then passes anterior to the circumflexus palati muscle and the eustachian tube, to enter the skull by the above-named foramen. In this course, exterior to the skull, it sends ramifications to the pterygoideus externus muscle, along the eustachian tube to the ear, and to the circumflexus and tensor palati muscles; some few ramifications passing into the foramen lacerum basis cranii anterius, to supply the dura mater. The course of the middle meningeal artery within the skull, may be traced from the spinous process of the sphenoid bone to the anterior edge of the squamous portion of the temporal; from whence it passes along a groove on the anterior and inferior angle of the parietal bone; from which point it proceeds in the course of the coronal suture, to terminate by a ramification which anastomoses with a corresponding one from the opposite side on the vertex of the skull. Immediately after its entrance at the foramen spinosum, it sends some small ramifications forward into the orbit by the foramen lacerum orbitale, to anastomose with the ophthalmic ramulus. Small ramifications pass backward to the aqueduct of fallopius, from whence other small distributions pass into the cavity of the tympanum; while larger ramifications pass in an anterior, middle, and posterior direction, to terminate in the supply of the dura mater, and bones of the skull.

(*β*.) *Ramusculus maxillaris inferior vel dentalis*—passes downwards and slightly forwards, between the neck of the lower jaw and internal lateral ligament, to enter the posterior maxillary foramen, accompanied with its corresponding nerve. In this course it gives off ramifications to the superior constrictor of the pharynx, buccinator, internal pterygoid, and mylo-hyoideus muscles. After entering the dental foramen, it takes its course in the mental canal of the body of the lower jaw, and gives off a ramification to each of the alveoli to supply the teeth; and the ramusculus terminates by two ramifications,—one passing out at the anterior maxillary foramen, anastomosing with ramifications of the facial ramusculi about the chin; the other continues within the bone, passing forwards to supply the incisor teeth.

The second portion of the internal maxillary ramulus, is directed obliquely upwards and forwards, and is placed between the two pterygoid muscles; being bounded above, by the insertion of the temporal muscle, and on the inner side, by the buccinator; in this situation, it supplies the capsular ligament of the temporo maxillary articulation. The masseter, buccinator, pterygoid, and temporal muscles, sending ramusculi to each, which are named according to their respective distributions, viz.:—(γ.) *ramusculi capsulares;* (δ.) *ramusculi masseteres;* (ε.) *ramusculi buccales;* (ζ.) *ramusculi pterygoidei;* (η.) *ramusculi temporales profundi posteriores.*

The third portion of the internal maxillary ramulus, resumes the horizontal direction of the first portion, passing forwards in the zygomatic fossa, parallel with the zygoma. In this course it sends upwards ramusculi of considerable size, the (ϑ.) *ramusculi temporales profundi anteriores,* which ramify upon the temporal muscle, in the anterior region of the temporal fossa, anastomosing on the outer brim of the orbit with ramifications of the ophthalmic ramulus. This third portion next gives off the (ι.) *ramusculus dentalis vel maxillaris superior,* a ramusculus of considerable size, arising near the tuberosity of the superior maxillary bone; it passes forwards in a serpentine direction around the body of the bone approaching the alveolar processes, to perforate their small opening and supply the roots of the teeth; it also sends ramifications through the body of the bone, to supply the mucous membrane of the antrum, and expends itself by anastomosing with the infra orbitar ramusculus above, and in the supply of the gums below. The third ramusculus in this course of the internal maxillary ramulus is (κ.) *ramusculus infra orbitalis,* passes forwards over the tuberosity of the superior maxillary bone, through the foramen lacerum orbitale inferius, to enter the infra orbitar canal, the whole length of which it traverses, passing out at the termination of this canal in the infra orbitar foramen. The ramusculus then gains the face immediately under the orbit, anastomosing freely with the facial and temporal ramuli. While within the orbit, it sends off some ramifications to the fat and muscles, and others to supply the mucous membrane within the antrum.

The fourth and last portion of the internal maxillary ramulus takes its direction downwards, forwards and inwards, between the two origins of the external pterygoid muscle, and gains the spheno maxillary fossa, where it terminates by dividing into the following ramusculi.

(λ.) *Ramusculus palatinus superior vel descendens.*—This vessel passes vertically downwards into the pterygo-maxillary fissure, and enters the posterior palatine canal, which terminates in a foramen at the posterior part of the palate bone; the vessel passes from thence, forwards, between the membrane and the vault of the palate; giving off numerous ramifications to the mucous membrane and its follicles, and terminates by a small ramification which passes upwards through the foramen incisivum into the nose, to anastomose with the lateral nasal ramusculus.

(μ.) *Ramusculus nasalis vel spheno palatinus*—is separated from the inner side of the internal maxillary ramulus, and enters the nose through the spheno palatine foramen, at the posterior part of the upper meatus; it divides into numerous ramifications to supply the pituitary membrane of the septum, and superior turbinated bones; and some pass into the anterior and superior ethmoidal cells, anastomosing within the nose with the ascending ramusculus of the superior palatine. From the spheno maxillary fossa there are two other ramifications found, which usually arise from one or the other of the ramusculi just described; although by some anatomists they are attributed to the internal maxillary itself.

One of these, and which most frequently is from the superior palatine ramusculus, takes its course backwards through the pterygoid canal with the vidian nerve, and is lost in ramifications on the eustachian tube and upper part of the pharynx.

The second, and still smaller ramification, is usually given off by the spheno-palatine, and is termed the superior pharyngeal ramification, which takes its course backwards, from the entrance of the spheno-palatine foramen into the nose, to be distributed to the upper part of the pharynx and eustachian tube, anastomosing freely with the ascending or inferior pharyngeal ramification of the external carotid ramus.

(B.) *Ramus carotidis internus vel cerebralis*—so called because it supplies the parts within the cranium. This ramus commences from the bifurcation of the common carotid, on a plane with the lower part of the third cervical vertebra, and opposite the superior part of the thyroid cartilage of the larynx; from this point it ascends through the cervical region to the base of the skull, where it enters the foramen caroticum of the temporal bone, taking the tortuous course of this canal: and, lastly, it terminates within the interior of the skull by perforating the dura mater, just above the anterior clinoid processes of the sphenoid bone, where it sends off its cerebral branches.

To facilitate the history of this ramus, it may be described in three portions: its first or cervical portion, extends from the transverse process of the third cervical vertebra to the foramen caroticum of the temporal bone. In this course its direction is not straight, but forms several flexuosities, which vary in different subjects. At its origin, this portion is directed outwards, towards the side of the neck; it then ascends inwards and a little forwards, becoming deeper and more tortuous as it approaches the entrance of the carotid canal. In this extent it does not give off any ramuli; it has in front of it, the external carotid with its ramuli, the styloid process and its muscles, the digastric muscle, the parotid gland, the facial, lingual, and glosso-pharyngeal nerves; behind it, the m. rectus capitis anticus major, the par vagum, and ganglion of the sympathetic nerve; external, and rather posterior to it, the external jugular vein, and lingual nerve; the latter, as it passes outwards from the anterior condyloid foramen, is at first in front of the vein and behind the artery; then, as it passes downwards and forwards, external to these vessels, and at the anterior part of the neck, it becomes superficial to both external and internal carotids. Internally, this division of the carotid has the pharynx on its inner side, more closely connected to it by cellular membrane below than at its superior part; while the tonsils are internal, more anterior, and connected to the ramus only by loose cellular membrane.

The middle division of the internal carotid, enters the carotid canal posterior to the eustachian tube and levator palati muscle; at first ascending, then it turns obliquely forwards, then upwards and inwards, and lastly, it ascends, inclined a little backwards, gaining the foramen lacerum anterius. In this course, the artery lies at first anterior and external to the tympanum and labyrinth; it then turns obliquely forwards, parallel with the entrance of the eustachian tube. In this first portion of the tortuous carotid canal, the artery is accompanied with two or more branches of nerves from the superior cervical ganglion; these form a plexus around the posterior and external part of the ramus, more numerous than to any other part of the arterial system. The ramus at this point gives off a small ramification, which enters the anterior and inferior part of the tympanum, to be distributed on the mucous membrane covering the promontory, and anastomosing with a ramification of the middle meningeal ramusculus; also a small ramification passes to the vidian canal.

The ramus carotidis internus, at the upper part of its middle second portion, passes upwards and a little forwards to enter the cavernous sinus of the dura mater, along the anterior portion of the lower wall of which it runs, giving off two or more ramuli, termed the ramuli receptaculi. These form an interlacement with the nerves of the cavernous ganglion; some ramusculi passing outward to the ganglion of the fifth pair, to anastomose with the middle meningeal ramusculus of the external carotid on the dura mater; also two or three ramifications to the dura mater, the pituitary body, the membrane of the sphenoidal sinuses, and the trunks of the neighbouring nerves.

The third portion of the internal carotid ramus commences at the side of the sella tursica, where it has perforated the dura mater; here it may properly be termed cerebral. After penetrating the dura mater, just externally and posterior to the optic nerve, the ramus ascends, and is inclined obliquely backwards and outwards, presenting a convexity towards the optic foramen, and being surrounded by a sheath of the arachnoid membrane. Opposite the internal extremity of the fissura Sylvii, this ramus terminates by dividing into its ophthalmic and cerebral ramuli.

(*a.*) The *ramulus ophthalmicus*—is given off from the convexity of the internal carotid ramus, where it faces the foramen opticum—through which it passes, being destined to supply the eye and its appendages. In traversing the optic foramen, with the optic nerve, it is first placed below and to the outer side of that nerve; it then crosses above it to gain the inner side of the orbit, and terminates at the inner canthus, by distributing ramusculi to the upper part of the face. While the ophthalmic artery is below and to the outer side of the optic nerve, it sends off the following ramusculi.

(*α.*) *Ramusculus lacrymalis*—which is the largest of its ramusculi, takes its course along the upper edge of the abductor oculi muscle, to gain the lachrymal gland, to which it is distributed. In passing from its origin to its termination, it sends out some ramifications externally through the malar bone, to anastomose with the deep temporal ramusculus of the internal maxillary. Within the orbit, also, it anastomoses with the middle meningeal ramusculus; and ultimately supplies the palbebra, anastomosing with the palpebral ramusculi.

(β.) *Ramusculus centralis retinæ*—also arises from the ophthalmic on the outer side of the ophthalmic nerve, which it soon penetrates, running along its axis to be distributed in minute branches upon the medullary expansion of the retina. Some of these small ramifications pass as far as the corpus ciliare; from which, in a very successfully injected eye, smaller ramifications may be traced to the crystalline lens. A very minute ramification may usually be seen running through the centre of the vitreous humour. The ophthalmic ramusculus having gained the superior surface of the optic nerve, sends off the (γ.) *ramusculus supra orbitalis*. This vessel passes upwards, above the levator palpebræ superioris, accompanied by the frontal nerve, and perforates the supra orbitar foramen to be distributed on the forehead. Within the orbit it sends off minute ramifications to the levator palpebræ, levator oculi muscles, and to the periosteum; when having issued from the superciliary foramen, it divides into internal and external ramifications. The internal anastomose with the nasal ramusculi of the facial, and with the corresponding ramifications of the opposite side; while the external pass outwards, to anastomose with the superficial temporal ramusculi. This ramusculus also supplies the upper eyelid, and the diploe of the frontal bone. The ophthalmic ramulus next gives off (δ.) *ramusculi ciliares* — which are very small, and are very frequently given off by other ramusculi of the ophthalmic ramulus. These ramusculi form three or more primary vessels, which surround the optic nerve, and then penetrate the sclerotic coat by twenty to thirty ramifications; most of these terminate in the choroid coat, and are named the short ciliary arteries: while on either side, parallel with the long axis of the eye, ramifications are seen passing between the sclerotic and choroid membranes, as far as the corpus ciliare, —these are termed the long ciliary arteries; which, passing under the ligamentum ciliare, subdivide, and forming frequent inosculations with each other, produce a circle of blood-vessels at the circumference of the iris. From the whole of the inner side of the circumference of this circle, a great number of ramifications arise, which immediately bifurcate, and again anastomose so as to form a second vascular circle within the preceding: while again, from the inner circumference of this second circle, small vessels form radii towards the circumference of the pupil to form a third circle, by their anastomosing with each other. About two lines behind the transparent cornea, small ramifications enter the eye, which are given off from the muscular ramusculi, to be distributed to the anterior part of the choroid coat and iris. These have been termed the anterior ciliary arteries; they form numerous anastomoses with the long and short ciliary arteries, and together send ramifications both to the iris and ciliary processes.

(ε.) The *ramusculi musculares*—are irregular in their number and origin, coming off in one or two vessels from the ophthalmic, lachrymal, or supra orbital ramusculi. The superior ramusculus supplies the levator palpebræ superioris and levator oculi, and attollens oculum. The inferior ramusculus, more constant than the superior in its origin and larger in size, arises from the ophthalmic, between the ciliary or immediately after the lachrymal ramusculus. It descends on the inner side of the optic nerve, sending ramifications to supply the rectus externus, the rectus inferior, and the obliquus muscles; small ramifications to the adeps and periosteum, inferior eyelid and lachrymal sac; and others which anastomose with the infra-orbital ramusculus; and the ramifications, from four to five in number, which have already been described as anastomosing with the ciliary arteries. The ophthalmic ramulus having gained the inner side of the optic nerve, sends off the following ramusculi—(ζ.) *ramusculus æthmoidalis posterior, et anterior.* These are frequently given off in a single vessel, which often divides into two branches to pass to the corresponding anterior and posterior orbitar foramina; at other times, they are distinct ramusculi. The *ramusculus æthmoidalis posterior*—passes forwards along the orbitar plate of the æthmoid bone, to enter the posterior orbitar foramen; and having gained the interior of the skull, it divides into ramifications to supply the ethmoid cells, and the anterior part of the dura mater. The *ramusculus æthmoidalis anterior*—continues still farther forwards along the inside of the orbit, until it reaches the anterior orbitar foramen, through which it passes, accompanied by the ethmoidal ramification of the ophthalmic nerve; it is then distributed to the anterior ethmoidal cells, sending some ramifications downward to the nose, through apertures on the cribriform plate of the ethmoid bone to be distributed to the pituitary membrane.

(η.) *Ramusculus palpebralis superior, et inferior*—arise generally from the ophthalmic, near the inner canthus, and a little beyond the cartilaginous pully of the obliquus oculi superioris. The superior palpebral ramusculus supplies the upper half of the orbicularis palpebrarum, and parts adjacent. There is one small ramification running forwards on the edge of the superior tarsal cartilage to the Meibomian glands, finally anastomosing with the supra orbital ramusculus. The inferior ramusculus descends behind the tendon of the orbicularis palpebrarum, furnishing ramifications to that muscle, lachrymal sac and caruncula; then to the inferior part of the orbicularis palpebrarum; while another ramification, more outwards, is distributed to the tarsus, Meibomian glands, and tunica conjunctiva. It anastomoses with the angular, lachrymal, infra orbitar, and temporal ramusculi. The ramusculi by which the ophthalmic ramulus terminate, are—

(ϑ.) *Ramusculus nasalis.*—This vessel is given off above the tendon of the orbicularis palpebrarum, and below the pully of the obliquus internus; it descends along the side of the root of the nose, and distributes minute ramifications to the lachrymal sac, neighbouring muscles, and anastomoses with the facial ramulus.

(ι.) *Ramusculus frontalis*—the last vessel given off by the ophthalmic, ascends from the upper and inner part of the orbit, underneath the orbicularis palpebrarum; it divides into several ramifications, which are distributed to the orbicularis palpebrarum, frontalis, and corrugator supercilii muscles; anastomosing with the superficial, temporal, supra orbital, and the opposite frontal ramusculi.

The internal carotid artery is but little diminished in size by the separation of the ophthalmic ramulus. Its remaining ramuli should be examined by removing the brain from the interior of the skull, with its arteries injected, in order to demonstrate them in their relative position. In the removal of the brain, the internal carotid will be necessarily divided, and should be separated immediately posteriorly to its ophthalmic ramulus. The next ramulus given off by the internal carotid, is the

(*b.*) *Ramulus communicans posterior.*—This directs itself backwards and slightly inwards, to anastomose with the posterior cerebral ramusculi of the ramulus basilaris; and thus forming a considerable portion of the circle of Willis. This communicating ramulus is placed between the pia mater and tunica arachnoidea, to the outer side of the infundibulum and mammillary processes, and to the inner side of the middle lobe of the brain. In its course it gives off small ramusculi to the thalamus nervi optici, and optic nerve of its own side; to the infundibulum, processus mammillaris, and peduncles of the brain. A ramification to the choroid plexus is sometimes given off from this communicating ramulus, at others from the internal carotid itself; in either case, entering the anterior extremity of the inferior cornu of the lateral ventricle.

(*c.*) *Ramulus cerebri anterior*—is the next branch given off by the internal carotid; it directs itself forwards and inwards, to reach the fissure between the two anterior lobes of the brain; and in passing forwards, converges towards its fellow on the opposite side, where they soon become connected through the intervention of the ramulus communicans anterior. After this junction, the anterior cerebral ramulus still continues forwards as far as the anterior extremity of the corpus callosum, around which they turn upward, and reach the upper surface of that body, where they gain the name of (α.) *ramusculi corporis callosi*—and pass to terminate in ramifications, which are distributed to the inner surface of each hemisphere of the brain as far as the posterior lobes. Before the ramulus cerebri anterior passes around the corpus callosum, it distributes small ramusculi to the fornix, and the anterior commissure of the third ventricle.

(*d.*) *Ramulus cerebri medius*—is the terminating branch of the internal carotid, and is much larger than the preceding; it passes backwards and outwards to gain the fissura Sylvii, where it divides into two considerable ramusculi; the one passing to the anterior, the other to the middle lobe of the brain, to be distributed to the pia mater of both of these lobes, but principally on the latter. A ramification of this vessel enters the inferior cornu of the lateral ventricle to supply the plexus choroides, and sometimes constitutes the true choroid ramusculus; but which is as frequently sent off, either from the internal carotid, or ramulus communicans posterior.

(5.) *Of the Subclavian Arteries.*

The arteriæ subclavii, similar to the carotids, do not arise alike on each side; the one on the right commencing from the arteria innominata, and that on the left from the arch of the aorta. The portion of the left subclavian, arising within the chest from the arch of the aorta, has been described (*Vide* p. 10); but should be again studied by the pupil, before he begins to examine the remaining portions of the subclavian arteries, which are so nearly similar on both sides, that the description of one will serve for both vessels.

They commence from the sterno clavicular articulations, and terminate at the anterior edge of the first rib. On examining the commencement of each artery from this spot, there is some difference to be observed between the right and left: the former, passing outwards in a gentle curve from the arteria innominata; while on the contrary, the left takes a very sudden turn, forming a considerable angle with its thoracic portion, as it directs itself outwards towards the scalenus anticus muscle.

In this extent, from the sterno clavicular articulation, to the first rib, the subclavian arteries form a curve, the convexity of which is directed upwards, and the concavity downwards towards the apex of the lungs, which they in part enclose.

The subclavian arteries, in this course, may be divided into three parts: the first third, between the sterno clavicular articulation, and the inner, or tracheal edge of the scalenus anticus muscle; the middle third, while between the two scaleni; and the outer third, while between the acromial or outer edge of the scalenus, and the anterior edge of the first rib.

Each of these portions presents sufficient surgical and anatomical interest, to render their separate description adviseable.

The first or tracheal portion, extending from the sterno clavicular articulations to the scalenus muscle, is deeply seated, and covered by the following parts, besides the skin and platysma myoides:—The sternum and clavicle, sterno cleido mastoideus, sterno hyoideus, and sterno thyroideus muscles; the par vagum, the anterior filaments of the inferior cervical ganglion of the sympathetic nerve, and the jugular and vertebral veins: behind this portion of the artery are found, the posterior branches of the sympathetic, and on the right side the recurrent laryngeal nerve; which nerves pass between the artery, and the longus colli muscle. It is this portion of the subclavian artery which sends off all its branches, excepting one; and for this reason, as well as from its depth and contiguity to important parts, the possibility of its being made the subject of operation for aneurism is precluded.

The second, middle, or scalenar portion of the subclavian artery, is placed between the scalenus anticus, and scalenus medius muscles. In front of the scalenus anticus, the phrenic nerve passes downwards vertically into the chest; consequently at right angles with the artery, and separated from it by that muscle. The subclavian vein passes in front of both muscle and nerve, in its course to the vena innominata. This portion of the artery has its concavity resting on the pleura covering the apex of the lung, and gives off one branch to the deep region of the neck. Like the former, it is not made the subject of operation from its deep situation between the scaleni muscles.

The third, or acromial portion of the subclavian artery, extends downwards and outwards, accompanied by the brachial nerves, and omo hyoideus muscle, which are above and to its outer side. It is the most superficial part of the artery, being covered only by integuments, platysma myoides muscle, cervical fasciæ, and glands. It rests behind, upon the scalenus medius muscle, and first rib; and is bounded anteriorly and inferiorly, by the subclavian vein, and the termination of the external jugular.

It is this outer third of the subclavian artery, around which a ligature is placed to cut off the flow of blood to an aneurismal tumour in the axilla.

The branches which are sent off by the subclavian artery, are eight in number; seven of which arise from its tracheal third. The directions in which they are distributed, are three upward, three outward, and two downward. Those upward—first the

(A.) *Ramus vertebralis*—arises from the posterior and upper part of the subclavian artery, between the scaleni and longus colli muscle; and extends to the junction of the medulla oblongata with the pons varolii, where it terminates by uniting with the corresponding ramus of the opposite side, to form the basillary ramus; hence it is better to describe its cervical, and cerebral portions, separately.

In the neck, directly after the vertebral ramus is separated from the subclavian, it passes upwards in front of the transverse process of the seventh cervical vertebra, and behind the inferior thyroideal artery; and where generally, on gaining the transverse process of the sixth cervical vertebra, it enters its foramen, although sometimes it will pass up as high as the fourth, and then ascends the canal produced by the foramina common to the transverse processes of all the cervical vertebræ. In this course it passes in front of the cervical nerves, as they emerge from the spinal marrow; as soon as it enters the transverse canal, it is concealed by it until it reaches the space between the second and first cervical vertebræ, where it may be seen by removing the trachelo mastoideus muscle; making a curve in a vertical direction, to gain the foramen in the transverse process of the atlas; and then traversing it, passes inwards and backwards, forming a second curve in a horizontal direction, between the atlas and occiput,—embracing the posterior circular ligament of the occipito atlantal articulation, which it perforates below the suboccipital nerve, to gain the foramen magnum,

The cervical portion of the vertebral artery, while traversing the transverse canal, sends off numerous muscular ramuli in every direction, to supply the posterior, lateral and anterior muscles of the spine; and some small ramusculi pass inward to the medulla spinalis, through the intervertebral foramina, and anastomose with those of the opposite side. While between the vertebra dentata and atlas, where it has been described to form its vertical curve, it supplies ramifications to the deep muscles of the back; and while between the atlas and occiput, it sends off considerable ramifications under the complexus muscle, anastomosing with the occipital ramusculi, and with the deep cervical of the subclavian, on the semi spinalis colli muscle,—supplying also the recti postici, and obliqui capitis muscles; its transverse curve being, in fact, situated in the triangular space formed by them.

The vertebral ramus, then passes from the atlas to the foramen magnum, penetrating the posterior circular ligament and dura mater, gains the side of the medulla oblongata; and converging as it passes upwards and forwards towards the opposite side, it runs in a groove between the corpora pyramidalia and olivaria; and at the junction of the medulla oblongata with the pons varolii, the two vertebral rami meet to form the basilar.

While passing through the dura mater the vertebral ramus sends off its (*a.*) *posterior or occipital meningeal ramulus*, which ramifies upon the dura mater. The next vessel usually sent off from the vertebral is (*b.*) *ramulus spinalis posterior*—which directs itself downwards and obliquely inwards, towards the ramulus of the opposite side, and gradually expends itself in the spinal marrow of the lumbar region. The vessel of either side is frequently anastomosing with the other by small transverse ramusculi.

(*c.*) *Ramulus spinalis anterior*—which is not unfrequently a ramusculus of the inferior ramulus of the cerebellum, descends in a tortuous course along the anterior surface of the medulla oblongata, converging towards the artery from the opposite side, so as to unite near the foramen magnum,—producing one branch, which continues along the whole length of the anterior part of the spinal marrow, as far as the junction of the sacrum with the os coccygis, where it terminates by anastomosing with the lateral sacral arteries. In this whole extent, it also frequently anastomoses with the posterior spinal arteries.

(*d.*) *Ramulus cerebelli inferior vel posterior*—is generally given off by the vertebrals before they form the basilar, but not unfrequently from that vessel. It directs itself outwards across the corpora pyramidalia, separating the filaments of the pneumo-gastric from those of the accessory nerve, at the same time distributing small ramifications to them. The ramulus continues backwards and downwards in a serpentine direction, to gain the inferior surface of the cerebellum, upon the pia mater of which it is distributed.

(*e.*) *Ramulus basilaris*—which has already been mentioned as being formed by the union of the two vertebrals, extends from the posterior, to the anterior part of the pons varolii, commencing at the junction of that body with the medulla oblongata. In this course the ramulus lies in a groove of the pons varolii, posteriorly separating the sixth pair of nerves from each other, and giving small ramifications on either side to be distributed to the inferior surface of the pons varolii, the cerebellum, and the medulla oblongata. The basilary ramulus then terminates by dividing into two pair of ramusculi; the first to supply the cerebellum, the second the cerebrum.

(α.) *Ramusculus cerebelli anterior vel superior*—passes outwards to wind over the upper part of the tuber annulare, to ascend upon the upper surface of the cerebellum, immediately behind the tubercula guardrigemina, to which it sends ramifications, as well as to the pituitary gland, and the valve of Vieussens. Sometimes from this ramusculus, at others from the basilar itself, a ramification is sent to the ear, through the meatus auditorius internus, dividing the postio mollis from the postio dura. The superior arterial ramusculus of the cerebellum, terminates by distributing itself to the pia mater.

(β.) *Ramusculus cerebri posterior*—by which the basilar ramulus terminates, proceeds on either side forwards and outwards, at first parallel with the last described ramusculus, having the third pair of nerves between them. It still continues outwards, winding around the crus cerebri to gain the inferior surface of the posterior lobe of the cerebrum, to which it is finally distributed. Each of these ramuli receives the ramulus communicans from the internal carotid, which inosculates with them on the inner side of the third pair of nerves—thus completing the posterior portion of the arterial circle of Willis; the anterior part being formed by the anterior ramuli of the cerebrum, and their transverse communicating vessel.

Within the space surrounded by these ramuli, which is of a quadrangular figure, is placed the processus mammillares, the infundibulum, and the pons Tarini.

The ramus next given off by the subclavian, is a short vessel which divides into several ramuli; it is termed the

(B.) *Ramus axis thyroideus*—and is placed immediately on the tracheal, or inner edge of the scalenus anticus muscle. The ramuli usually given off by this trunk, are four in number; two of which are directed upward, and two outward. In this distribution, however, there occurs considerable variety; as occasionally one or two, or all of them, are given off from the subclavian artery separately.

(*a.*) *Ramulus thyroideus inferior, vel ascendens*—arises rather to the outer side of the vertebral ramus, and generally opposite to the origin of the internal mammary. It ascends along the inner edge of the scalenus anticus muscle, as high as the fifth cervical vertebra, where it is directed inwards to gain the thyroid gland, passing behind the carotid sheath and its contents, between it and the vertebral ramus,—which, however, is separated from it by its bony canal. In this course it sends off first numerous muscular ramusculi; and arriving at the side of the trachea, supplies it and the œsophagus; it then continues, but little diminished in size, to the posterior surface of the thyroid gland, to which it is distributed, — inosculating with branches of the superior thyroideal from the external carotid ramus.

(*b.*) *Ramulus cervicalis ascendens*—is a small branch either sent off from the last described artery, from the thyroid axis, or from the subclavian itself; it ascends along the inner edge of the scalenus anticus muscle, parallel with the phrenic nerve, first resting on the longus colli, then on the rectus capitis anticus major, reaching as high as the rectus capitalis lateralis,—in which course it supplies all these muscles; sending also small ramifications inward through the intervertebral foramina, along the roots of the cervical nerves, to anastomose with the spinal ramusculi of the vertebral ramus; with which latter it also anastomoses on the posterior part of the neck, upon the deep-seated muscles of that region.

(*c.*) *Ramulus transversalis, vel superficialis colli*—is most frequently given off from the thyroid axis on the inner side of the scalenus anticus muscle, which it crosses, as well as the brachial plexus of nerves,—being covered by the trapezius muscle. In this situation it sends off numerous small ramusculi to the muscles and nerves in this region; it then divides into the superficial cervical and posterior scapular ramusculi.

(α.) The *superficial cervical*—proceed in a tortuous direction upward, beneath the trapezius, to supply the superficial muscles of the back,—anastomosing with the occipital ramulus, and being lost in the integuments. It also sends some few descending ramifications along the posterior surface of the trapezius to the spine of the scapula, where it anastomoses with the supra scapular artery.

(β.) The *posterior scapular ramusculus*—which appears to be a continuation of the ramulus, passes, deeply covered by the rhomboidei and the levator scapulæ muscles, to gain the posterior costa of the scapula—along which it descends vertically, to terminate by anastomosing at the inferior angle with the infra scapular of the axillary artery. In this course it sends off numerous muscular ramifications, anastomosing with the deep cervical, and posterior ramifications of the intercostal rami.

(*d.*) *Ramulus supra scapularis*—is generally the last vessel given off from the thyroid axis, and like the above described ramulus it crosses the scalenus anticus in its course outwards, running parallel to the subclavius muscle, with which it is more or less connected by the fascia of the neck; it is covered by the trapezius muscle, and on reaching the superior costa, it passes over the posterior ligament of the scapula, which separates it from the supra scapular nerve,—both of them being placed between the origin of the omo hyoideus muscle, and the root of the coracoid process. While in its course to the posterior ligament of the scapula, it sends off small muscular ramifications; and at the ligament it sends off the superior acromial ramusculus, which perforates the trapezius muscle; and on the upper surface of the acromion supplies the deltoid,—anastomosing with the humoral thoracic ramulus of the ramus axillaris. A small ramusculus to the supra spinatus muscle is next given off in the fossa supra spinata, running to the posterior costa of the bone, and anastomosing with the posterior scapular branch of the superficial cervical ramusculus. The supra scapular ramulus terminates by a descending ramusculus, which passes through the acromial notch to gain the fossa infra spinata,—there dividing into several ramifications supplying the infra spinatus, the long head of the triceps, and teretes muscles; and anastomosing, posteriorly, with the posterior scapular ramusculus of the superficial cervical ramulus; and anteriorly, with the subscapular ramus of the axillary artery.

(c.) *Ramus mammillaris internus.*—It descends into the chest, taking its course downwards and inwards along the posterior surface of the cartilages of the ribs and external intercostal muscles, between them and the triangularis sterni. As it descends it diminishes in size, converging towards the artery of the opposite side; it reaches as low as the ensiform cartilage of the sternum, where it divides into its two terminating abdominal ramuli. When this ramus first enters the chest, it is crossed by the phrenic nerve, which is anterior to it, above being to its outer, and below to its inner side. In this situation the internal mammary ramus gives off four or five (*a.*) *anterior intercostal ramuli.* These pass first between the pleuræ and internal intercostal muscle, and then between the internal and external intercostal muscles; and expend themselves by anastomosing with the posterior intercostal arteries of the aorta, and by distributing large branches to the mamma of the female, anastomosing with the thoracic branches of the axillary artery. Small ramusculi are distributed to the anterior mediastinum and its contents, and supply the remains of the thymus gland; and others pass to the pericardium, pleura, and diaphragm.

The next ramulus from the internal mammary is so regular in its course accompanying the phrenic nerve, that it has been named (*b.*) *ramulus, comes nervi phrenici*—

it supplies the diaphragm, upon which it is lost. In the interspace between the cartilages of the sixth and seventh ribs, the internal mammary divides into its phrenic and abdominal ramusculi.

(*c.*) *Ramulus diaphragmaticus vel phrenicus*—takes a course outwards, along the cartilages of the last rib, and distributes itself to the diaphragm, and to the transversalis abdominis muscle; anastomosing with the inferior intercostal, superior lumbar, and circumflex ilii vessels.

(*d.*) *Ramulus abdominalis*—on descending, passes behind the rectus muscle, and anastomoses with the ascending ramusculus of the epigastric.

(D.) *Ramus intercostalis superior*—is the last branch given off from the first third of the subclavian artery, from the posterior part of which it arises, close to the scalenus anticus muscle. It then takes its course downwards, along the posterior parietes of the chest, but anterior to the neck of the first rib, at the inferior edge of which it sometimes terminates, while at others it passes in a similar manner in front of the second, and even of the third rib. In the intercostal space or spaces, according to the length of this vessel, it divides into posterior and external ramuli.

(*a.*) *Ramulus posterior*—directs itself backwards, between the transverse processes of the dorsal vertebræ, dividing into muscular and internal ramusculi. The internal passing through the intervertebral foramina to supply the spinal marrow, the muscular are distributed to the deep-seated muscles of the back.

(*b.*) *Ramulus externus*—is distributed to the intercostal muscles, sending some few ramusculi forwards to the œsophagus and bronchi. In the second intervertebral space, the ramus intercostalis superior terminates by two ramuli, precisely similar to the preceding vessels, anastomosing with the upper intercostal arteries from the aorta.

(E.) *Ramus cervicalis profundus, vel posterior*—is usually given off from the middle third of the subclavian artery, while placed between the two scaleni muscles; but is sometimes arising in common with the superior intercostal artery. This ramus first passes upwards, outwards, and backwards, gaining the interspace of the transverse processes of the sixth and seventh cervical vertebræ—in this passage generally separating the axillary plexus of nerves. Having gained the posterior region of the cervical vertebræ, it ascends between the spinous and transverse processes of those bones, and divides into numerous muscular ramuli—supplying the deep layer of muscles of the cervical region. One ramulus is particularly observable, which passes upwards between the semi-spinalis colli, and complexus muscles, to inosculate with the occipital and vertebral ramifications—this vessel maybe termed (*a.*) *ramulus anastomodicus.*

(5.) *Arteria axillaris.*—This vessel cannot be considered as a ramus of the subclavian artery, being in fact, as well as the brachial, the continuation of the main trunk of that vessel; and which anatomists have named arteria axillaris, and arteria brachialis, to facilitate the description of its course through the regions in which it is situated; and I may therefore, consistently with the plan which I have adopted, still denominate these vessels as arteries.

The arteria axillaris extends from the anterior edge of the first rib to the inferior edges of the latissimus dorsi, and teres major muscles. In this course, when the arm is hanging by the side, the artery forms a curve, the convexity of which is directed upwards and outwards, and the concavity downwards and inwards.

The axillary artery may be divided into three portions, sufficiently marked by its relative position with the axillary plexus of nerves. The upper third has the whole of the axillary plexus above and to its outer side; the middle third is completely surrounded by this plexus; while the inferior third has the median nerve in front of it, the spiral and circumflex nerves behind it, the external cutaneous nerve to its outer, and the internal cutaneous and ulnar nerves to its inner side.

The muscles which cover the axillary artery anteriorly, arc, the platysma myoides, pectoralis major, pectoralis minor, coraco brachialis, and biceps; its accompanying vein is also anterior to it. The artery rests upon the first intercostal muscle, in the upper digitation of the serratus magnus, from which muscle it then becomes separated by a considerable quantity of cellular membrane; and just before its termination, it lies upon the tendinous insertions of the latissimus dorsi and teres major.

The rami which are distributed from the axillary artery, although irregular in their number, pass inward to supply the exterior of the thorax, outward to supply the muscles of the shoulder, and backward to supply the glands and adeps within the axilla.

The internal rami, generally four in number, are termed—rami thoracici, and are distinguished by the following names.

(A.) *Ramus thoracicus acromialis*—is of considerable size, and is separated from the fore part of the axillary artery immediately above the upper edge of the pectoralis minor, where it is concealed by the pectoralis major. It then takes its course upwards, outwards, and forwards, to gain the anterior edge of the deltoid muscle; sending off ramuli to the subclavius, serratus magnus, and intercostal muscles, and then dividing in two terminating ramuli.

(*a.*) *Ramulus superior*—ascends between the deltoid and pectoralis major muscle, as high as the acromio clavicular articulation; when it divides into two ramusculi,—the inner to supply parts about the clavicle, the outer distributed to the capsular ligament of the shoulder-joint, and the under surface of the deltoid muscle; and terminating by anastomosing with the ramulus supra scapularis.

(*b.*) *Ramulus inferior*—takes its course downwards, between the pectoralis major and deltoid muscles, accompanying the vena cephalica; and terminates by small muscular ramusculi, some of which anastomose with the rami articulares.

(B.) *Ramus thoracicus supremus*—is not unfrequently arising in common with the last described ramus, but generally immediately below it. It passes inwards along the superior edge of the pectoralis minor muscle, and distributes itself to both pectoral muscles—the larger of which must be removed in order to expose this ramus. It also supplies in part the parietes of the thorax, inosculating with the ramus mammillaris internus, and the rami intercostales.

(C.) *Ramus thoracicus longus*—arises from the axillary artery, below the last two rami, and just at the inferior edge of the pectoralis minor muscle, along which it takes its course forwards and downwards, between the pectoralis major and the serratus magnus muscles, to both of which it is distributed; and becoming subcutaneous, it divides into small ramifications, which supply the mammæ. It anastomoses with the intercostales internal mammary and superior thoracic rami.

(D.) *Ramus thoracicus alaris.*—This branch is very irregular as to its origin, frequently arising from some of the thoracic branches, and is sometimes entirely wanting. When arising from the axillary artery, it is given off about the middle of the axilla, and soon divides into numerous ramuli to supply the glands and cellular membrane in the cavity of the axilla—anastomosing with the intercostal arteries; and from them they sometimes arise.

(E.) *Ramus subscapularis*—is separated from the axillary artery at the lower edge of the subscapularis muscle, and behind the axillary plexus. This branch takes its course along the inferior edge of the subscapularis, for about an inch and a half, when it divides into an anterior and a posterior ramulus; previous to which, however, it gives off some minute ramuli, to supply the glands in the axilla, and the subscapularis muscle.

(*a.*) *Ramulus anterior*—appears as if a continuation of the ramus subscapularis, taking its course along the lower edge of the subscapularis muscle, to the inner side of the serratus magnus and latissimus dorsi,—to both of which muscles it sends ramusculi. Close to the inferior angle of the scapula it subdivides into numerous ramusculi, which are distributed to the teretes muscles, and anastomose freely with the ramusculus scapularis posterior, of the ramulus transversalis colli, from the thyroid axis.

(*b.*) *Ramulus posterior*—winds around the anterior costa of the scapula, to gain the dorsum of that bone, passing in a space which is bounded in front by the long head of the triceps, below by the teretes, and above by the glenoid cavity. In this situation it sends off ramusculi to each of the above-named muscles; from hence it passes to the fossa infra spinata, dividing into two principal sets of ramusculi —one superficial and the other deep. The superficial set supplies the integuments upon the dorsum of the scapula; while the deep set passes between the bone, the infra spinatus, and teres minor muscles; while one principal ramification continues under the acromial notch to gain the fossa supra spinata, where it anastomoses with the ramulus supra scapularis; and posteriorly with the posterior scapular ramulus; and at the inferior angle of the scapula with the ramulus anterior.

(F.) *Ramus articularis, vel circumflexus posterior*—is the next branch given off from the axillary artery, arising from its posterior part, and sometimes in common with the last-described ramus. It takes its course backwards, between the neck of the humerus and the long head of the triceps muscle; below the capsular ligament of the shoulder-joint, and above the tendon of the latissimus dorsi; from whence it continues around the bone, encircling its neck—being here covered by the deltoid muscle. In this situation it sends off ascending, and descending ramuli. The superior supply the deltoid muscle, and ascend as high as the acromion process and shoulder-joint—anastomosing with the ramus thoracicus acromialis. The inferior ramuli pass downward, along the tendon of the deltoid muscle, to anastomose with the ramus profundus superior of the brachial artery, and with the ramus circumflexus anterior. This ramus has an accompanying nerve, arising from the axillary plexus.

(G.) *Ramus articularis, vel circumflexus anterior*—is a smaller vessel than the preceding ramus, and is usually sent off from the axillary artery immediately below it. They however sometimes arise by a common ramus; at others it arises from the ramus subscapularis, or from the ramus profundus superior of the brachial artery. It directs itself under the coraco brachialis muscle, and the short head of the biceps; and thus passing behind the deltoid muscle, anastomoses with the posterior ramus. In this course it gives off ascending and descending ramuli;—the former to supply the capsular ligament, and the synovial membrane of the shoulder-joint; the latter are distributed to the muscles of the arm, and anastomose with the ramifications of the brachial artery. Such are the rami usually distributed from the axillary artery; but it not very unfrequently occurs, that this vessel divides high in the axilla into two equally-sized branches, producing great variety in its distributions. And this is a circumstance also attended with important pathological considerations, which will hereafter be alluded to.

(5.) *Arteria brachialis*—still a continuation of the subclavian, proceeds from the lower edge of the tendon of the teres major muscle, to the bend of the elbow; where usually opposite to the coronoid process of the ulna, it divides into its terminating rami. In this course it does not pass directly vertically, but obliquely from above to below, and from behind to before. It is covered, first, by the coraco brachialis muscle, by the inner edge of the biceps, and by the fascia of the arm; but at the bend of the elbow it sinks deeper, and is covered by the aponeurosis of the biceps muscle, and the pronator radii teres. Posteriorly, it rests upon the triceps, the tendinous insertion of the coraco brachialis, and the brachialis internus muscle. The superficial veins are separated from the artery by the fascia of the arm, but the artery has its venæ comites accompanying it. The brachial artery sends off numerous branches to supply the muscles of the arm, and may be described as anterior, posterior, external, and internal branches. The three first sets supply the muscles in their corresponding situations, and have no distinct names; but the internal rami form most essential anastomoses, and are therefore denominated accordingly.

(A.) *Ramus profundus superior.*—This branch is sometimes given off by the subscapularis, or posterior circumflex ramus; but when from the brachial artery, it is separated from it about an inch below the tendinous insertion of the teres major; it then takes its course backwards and outwards, between the triceps and the humerus, continues around to the back part of the humerus, penetrates the second portion of the triceps muscle, and then becomes anterior to the bone, and is placed between the triceps and brachialis internus muscles—losing itself in numerous muscular and anastomosing ramifications, upon the outer side of the elbow-joint. In this course it sends off several ramuli; first to the triceps, immediately after its separation from the brachial artery; while between the triceps and the middle of the back part of the humerus, it sends a ramulus along the bone as far as the olecranon of the ulna, to supply the elbow-joint, and anastomose with the recurrent ulnar and recurrent interosseal ramuli: near the elbow, just above the external condyle of the humerus, the ramus profundus terminates by dividing into anterior and posterior ramuli. The anterior descend between the supinator radii longus and brachialis internus muscles, deeply seated, and having the spiral and external cutaneous nerves, and cephalic veins anterior to them. These anastomose with the recurrent radial ramuli. The posterior ramuli pass behind the ridge of the external condyle, and anastomose with the recurrent interosseous ramusculi.

It is the ramus profundus superior which, proceeding from the inner to the outer side of the arm, anastomoses with the recurrent radial, and is the principal means of carrying on the circulation in obliteration of the brachial artery.

(B.) *Ramus profundus inferior*—is given off from the inner side of the brachial artery, just at the insertion of the coraco brachialis muscle; directly after its origin, it penetrates the intermuscular ligament, which proceeds from the insertion of the coraco brachialis to the internal condyle; it descends to the fossa between the internal condyle and processus olecranon of the ulna; here being accompanied by the ulnar nerve, it terminates in numerous ramuli, which freely anastomose with the ramus anastomoticus magnus, and ramuli recurrentes ulnaris. In this course it sends off nothing but small distributions to the muscles; lying at first upon the tendon of the coraco brachialis, and in the rest of its extent upon the third head of the triceps muscle.

(C.) *Ramus anastomoticus magnus*—is given off from the brachial artery, in the inferior third of the arm, and close to the internal condyle; it immediately directs itself transversely inwards, crossing the brachialis internus muscle behind the median nerve; it then perforates the intermuscular tendon between the brachialis internus and triceps, and divides into two ramuli: the anterior sends up superior ramusculi to anastomose with the ramus profundus inferior; and inferior ramusculi descend in front of the internal condyle, to anastomose with the anterior recurrent ulnar ramusculi. The posterior ramuli take their course downward, between the olecranon and internal condyle, giving ramusculi also to anastomose with the ramus profundus inferior, and with the posterior recurrent ulnar ramusculi.

(D.) *Ramus nutritius humeri*—is a small branch given off from the brachial, generally at the insertion of the coraco brachialis muscle, the tendon of which it perforates, and immediately enters the nutritious foramen of the os humeri, which is directed from above downwards.

The brachial artery terminates at the bend of the elbow, opposite the coronoid process of the ulna, in the ramus radialis and ramus ulnaris. The division of the brachial artery into these rami, is not always situated at this point, but occasionally occurs at various distances above it, and sometimes as high as the axilla.

(E.) *Ramus radialis*—is smaller, and more superficial than the ramus ulnaris; but appears, from its direction, more like a continuation of the brachial artery. It extends from its division from the brachial to the palm of the hand, where it terminates by forming the deep palmar arch. In this course, it may first be described in front of the radius, next behind the carpus, and lastly in the palm of the hand.

In front of the radius, it first lies upon the supinator radii brevis, separated from it by a small quantity of adeps, and cellular membrane; it then crosses the insertion of the pronator radii teres; next it runs along the flexor tertii internodii pollicis, reaches the pronator quadratus, upon which it passes; and lastly, gains the radius, running around to the posterior part of the wrist-joint. It is covered anteriorly, in the superior third, by the supinator radii longus, and pronator radii teres; below, it is superficial, and its pulsation may readily be felt, being only covered by the integuments and aponeurosis of the fore arm. On its radial, or outer side, it is bounded by the supinator radii longus, and its accompanying nerve; on its inner, or ulnar side, it has above, the pronator radii teres, and below, the flexor carpi ulnaris.

The ramus radialis is usually accompanied by two venæ comites; and in front, although separated from it by the fascia of the fore arm, is placed the superficial radial vein. In this first part of the ramus radialis, numerous ramuli are sent off to supply the muscles:—anteriorly, to the pronator radii teres, aponeurosis, and integument of the fore arm; posteriorly, to the muscles already named, upon which it rests in its course; externally, to the supinator radii longus, and extensores carpi radiales; and internally, to the common flexors of the fingers, and wrist-joint. Besides these muscular ramuli, others are given off which are to be more particularly noticed.

(*a.*) *Ramulus recurrens radialis.*—This vessel is placed between the supinator radii longus, which covers it, and the supinator radii brevis, upon which it rests; and to both of which it sends ramusculi: it then directs itself upwards, in front of the external condyle of the humerus, between the supinator radii longus, and brachialis anticus muscles; where it divides into internal and external ramusculi:—the external anastomose with the ramus profundus superior; and the internal, in front of the elbow-joint, with the ramus anastomoticus magnus, the anterior recurrent ulnar, and interosseal ramuli.

(*b.*) *Ramulus superficialis volæ*—is given off usually about an inch above the carpus; it is very variable in its size, and passes superficially downwards, crossing the annular ligament, and origin of the muscles of the thumb—to both of which, as well as to the integuments of the palm of the hand, it distributes small ramusculi. It terminates with the extremity of the superficial palmar arch, which it may be said to complete.

This vessel is, however, so variable in its size, as sometimes scarcely to be distinguished; while at others, it is so large, as to appear like a continuation of the ramus radialis: under such circumstances, it not only forms an important part of the superficial palmar arch, but also distributes digital ramusculi to the thumb and fore finger.

While the ramus radialis lies upon the bone below the pronator quadratus muscle, it sends off—

(*c.*) *Ramulus radialis carpi anterior.*—This small vessel takes its course inwards, underneath all the flexor tendons of the fingers, and supplies the ligaments of the wrist-joint; anastomosing, above, with the ramulus interosseus, and internally, with its corresponding ramulus from the ulnar artery.

In the second part of the course of the ramus radialis, as it passes around the outer side of the carpus, it lies upon the ligaments of the wrist-joint, and upon the head of the first phalanx of the thumb—being covered by its three extensor tendons, and by the fascia and skin. In this situation, it gives off—

(*d.*) *Ramulus dorsalis carpi radialis*—which takes its course inwards, underneath the tendons of the extensors to the wrist and fingers—there supplying the ligaments of the joint; and terminates by anastomosing with a similar ramulus of the ulnar ramus. It distributes superior ramusculi to anastomose with the posterior interosseal ramulus, and inferior ramusculi which supply the interosseii muscles, and anastomose with the deep palmar arch.

(*e.*) *Ramuli dorsales pollicis*—generally arise by two ramuli, which proceed along the dorsum of the thumb to supply both its radial and ulnar sides; that on the ulnar side, sends a ramusculus to the radial side of the index finger, which has been named the (*α.*) *ramusculus dorsalis indicis.*

The ramus radialis, in its passage to the palm of the hand, passes between the abductor indicis and adductor pollicis muscles: in this situation, it divides into its three terminating ramuli.

(*f.*) *Ramulus magnus vel princeps pollicis*—passes forwards to the anterior edge of the adductor pollicis, and at the lower extremity of the first phalanx of the thumb; it divides into two digital ramusculi, which supply both radial and ulnar sides of the palmar surface of the thumb.

(*g.*) *Ramulus radialis indicis*—takes its course along the radial side of the fore finger, the palmar surface of which it supplies—anastomosing on the anterior phalanx with the ramulus ulnaris indicis of the superficial palmar arch. This ramulus, while in the palm, generally anastomoses also with the outer extremity of the superficial palmar arch.

(*h.*) *Ramulus palmaris profundus*—passes transversely from between the abductor indicis and adductor pollicis, sinking deeply into the palm of the hand; and resting upon the metacarpal bones and interosseii muscles, reaches the metacarpal bone supporting the little finger, where it terminates by anastomosing with the deep ramulus of the ramus ulnaris—thus forming the deep palmar arch. The convexity of this arch is directed downwards, and is placed in a space midway between the superficial palmar arch and the carpus, being covered by the flexor tendons of the fingers, and the lumbricales muscles. From the convexity of the arch are sent off ramusculi, to supply the interossei muscles, and these proceed forward to the anterior extremities of the metacarpal bones, to anastomose with the digital ramusculi of the superficial palmar arch: from the concavity of the deep palmar arch, small ramusculi are directed upward, to anastomose with the ramuli arteriores carpi.

(F.) *Ramus ulnaris*—extends from opposite the coronoid process of the ulna to the palm of the hand, where it terminates by forming the superficial palmar arch. It is larger than the radial ramus, and passes more obliquely downwards, being first situated between the superficial and deep layer of muscles; but about the middle of the fore arm it emerges from between them, becomes superficial, and passes vertically downwards to the ligamentum carpi annulare, where it is directed slightly outwards, passing anteriorly to the ligament on the radial side of the pisiform bone; and having gained the palm of the hand, it forms the superficial arch. In this course the ramus ulnaris is covered by the pronator radii teres, flexor carpi radialis, flexor sublimis digitorum, flexor carpi ulnaris muscles, and by the median nerve; below the middle of the arm, it is covered by the skin, and aponeurosis of the fore arm; in the hand, it lies beneath the palmaris brevis muscle, and palmar aponeurosis. It successively lies upon the brachialis internus, flexor digitorum profundus, ligamentum carpi annulare, and in the palm of the hand on the common flexor tendons of the fingers. On its ulnar side it is bounded by the ulnar nerve, and the flexor carpi ulnaris muscle; and while passing over the ligamentum carpi annulare, by the pisiform bone: on its radial side, it is bounded by the flexor digitorum sublimis.

The muscular ramuli which are given off from this branch, are as numerous as from the radial, and like them have no specific names. The following, however, require a more particular notice.

(*a.*) *Ramuli recurrentes anteriores*—generally arise by one common vessel, and soon divide into an anterior and posterior ramulus. The anterior takes its course outwards, between the pronator radii teres and brachialis internus muscles, and ascends in front of the internal condyle, inosculating with the ramus anastomoticus magnus, and the ramus profundus inferior.

The posterior recurrent ramulus is directed inwards behind the pronator radii teres, flexor carpi radialis, and flexor digitorum sublimis, between it and the flexor profundus; in this situation, taking the course of the tendinous origin of the flexor longus pollicis: it then ascends behind the internal condyle, between the two origins of the flexor carpi ulnaris, being placed between the olecranon and internal condyle, where it is accompanied by the ulnar nerve: it terminates by anastomosing with the deep, and anastomotic branches of the brachial artery. Both of these recurrent ramuli supply the muscles upon which they rest.

(*b.*) *Ramulus interosseus*—is sent off from the ramus ulnaris, underneath the flexor sublimis digitorum, taking a course outwards and backwards to gain the upper interosseous space, opposite to the tubercle of the radius, where it divides into an anterior and posterior ramusculus. Before this division, however, it sends off—

(*α.*) *Ramusculi recurrentes interossei anteriores.*—These are very small vessels, but they surround the coronoid process of the ulna, and anastomose with the recurrent ramuli of the radial and ulnar rami.

(*β.*) *Ramusculus interosseus anterior*—takes its course downwards from the tubercle of the radius, accompanied by a branch of the median nerve, being covered by the flexor longus pollicis and flexor profundus muscles, to the superior edge of the pronator quadratus muscle, where it divides into two ramifications. The anterior of these supplies the pronator quadratus, continues downwards to the front part of the wrist-joint, and anastomoses with both the radial and ulnar anterior carpal ramuli. The posterior ramification pierces the interosseous ligament, immediately above the pronator quadratus muscle; and descending along the back part of the radius, gains the posterior surface of the carpus, to inosculate with the posterior carpal ramuli of the radial and ulnar rami.

(γ.) *Ramusculus interosseus posterior*—takes its course backwards, from opposite the tubercle of the radius, through the interosseous hiatus, between the upper edge of the interosseous ligament, and the oblique ligament of the middle radio-ulnar articulation, where it is covered by the extensor longus digitorum communis, and anconeus muscles, both of which it supplies. It then divides into two ramifications, the superior of which takes its course upwards, between the anconeus and supinator brevis muscles, passing around the external condyle between it and the olecranon; it anastomoses freely with the superior profunda, recurrent radial, and recurrent ulnar ramuli. The descending ramification of the ramusculus interosseus posterior, does not run downwards on the interosseous ligament, but is situated between the extensor common to the fingers, and the proper extensors of the thumb. When it reaches the upper part of the dorsal surface of the carpus, it distributes itself by anastomosing with the posterior carpal ramuli of the radial and ulnar rami, and with the posterior ramification of the anterior interosseal ramusculus.

(*c.*) *Ramuli carpi ulnares anteriores et posteriores*—are given off from the ramus ulnaris, just above the styloid process of the ulna; and taking their course, as implied by their name, upon the anterior and posterior surfaces of the carpus, they freely anastomose with the corresponding ramuli of the radial ramus, and the ramifications of the interosseal ramusculus.

The ramus ulnaris, while passing over the anterior surface of the ligamentum carpi ulnare to the radial side of the pisiform bone, distributes small ramifications to the neighbouring ligaments, cellular membrane, and integuments, and then divides into its two terminating ramuli.

(*d.*) *Ramulus communicans, vel profundus*—takes a deep course, accompanied by a branch of the ulnar nerve, between the flexor brevis and abductor minimi digiti muscles, to inosculate with the deep palmar arch of the ramus radialis.

(*e.*) *Ramulus palmaris superficialis*—takes its course outwards, across the palm of the hand, to gain the centre of the metacarpal bone of the fore finger, where it anastomoses with the ramulus superficialis volæ, and the ramulus radialis indicis, thus completing the superficial palmar arch; the convexity of which is directed towards the little and index finger, and the concavity towards the ball of the thumb. A branch of the median nerve accompanies this arterial arch.

There are several ramusculi given off both from the convexity and the concavity of the superficial palmar arch. Those from the concavity, pass upward toward the carpus, to supply the lumbricales muscles, and anastomose with the anterior carpal vessels; those from the convexity, are generally four in number.

(*α.*) *Ramusculi digitales.*—The first or internal takes a course along the metacarpal bone of the little finger; it supplies the muscles proper to it, and terminates by being distributed to the ulnar side of the little finger. The second ramusculus runs in the interspace between the little and ring finger, and opposite the heads of the metacarpal bones; it divides into two ramifications, to supply the radial side of the little finger, and the ulnar side of the ring finger. The third ramusculus passes between the metacarpal bone of the ring and middle finger; and in like manner is divided, and supplies the radial side of the ring, and ulnar side of the middle finger. The fourth ramusculus is placed between the metacarpal bones of the middle and index fingers, and distributes itself to the radial side of the middle, and ulnar side of the index finger. The rest of the index finger, and the thumb, are supplied by similar distributions from the radial ramus. Each digital ramusculus has an accompanying branch, supplied from the median and ulnar nerves; and as they descend toward the extreme phalanx, they converge; and about the centre of the extreme phalanx, they unite so as to form arches, from the convexity of which numerous distributions are given off, supplying the cutaneous papillæ, accompanied by numerous filaments of nerves.

The THORACIC PORTION OF THE AORTA.—The name given to this portion of the aorta, it is to be remembered, does not apply to the whole of the vessel contained within the thorax; as in this sense, the arch of the aorta would also be implied by the term. The thoracic portion of aorta commences from the fourth dorsal vertebra, and extends to the twelfth, where it passes between the crura of the diaphragm, and becomes the abdominal aorta. In this course the aorta is not completely vertical, but passes obliquely from above to below, and from left to right, being first placed to the left of the bodies of the dorsal vertebræ: while on the twelfth dorsal vertebra, it is placed precisely in the mesian line. It also forms a slight curve, the convexity of which is directed to the right, and the concavity to the left—at the same time conforming to the bend of the column of the dorsal vertebræ, and consequently, being concave anteriorly, In this extent it is placed in the posterior mediastinum (for an account of which, *vide* page 185, Vol. III.), accompanied by the thoracic duct, vena azygos, œsophagus, and par vagum nerves. It lies close to the vertebral column,—separated, however, from it by the left intercostal veins, as they are seen passing to the vena azygos. After having observed the relative position of the thoracic aorta, the student should proceed to the enumeration of the arteries given off from it. These are described as anterior and lateral branches.

(6.) *Arteriæ bronchiales*—are the arteries given off from the fore part of the thoracic aorta; they are very variable in their origin, commonly however arising by two distinct arteries, one on either side; at others, by four separate vessels; and sometimes by a single vessel, which afterwards divides into four branches. They are given off from the aorta, whether in common or separately, opposite the fifth dorsal vertebra. The right bronchial artery, which not unfrequently arises from the superior intercostal, takes its course backwards, and to the right, immediately sending some small rami to the œsophagus; it then continues its course along the posterior surface of the right bronchus, upon which it divides into numerous minute rami—supplying the pleura, pericardium, and bronchial glands, and are finally distributed upon the ultimate divisions of the bronchi within the lungs.

The left bronchial artery, is separated from the aorta upon a level with the right, and is distributed in a similar manner upon its corresponding side.

(7.) *Arteriæ œsophageæ*—vary both in their number and their size; frequently being six or seven, and small; at others, only one, and proportionably large. They arise from the front part of the aorta, immediately below the bronchials, from which some of them are not unfrequently given off. They divide themselves into ascending and descending branches, which are distributed with the œsophageal plexus of nerves, to the coats of the œsophagus.

The superior rami anastomose with the œsophageal ramifications of the inferior thyroid ramulus of the subclavian artery; and the inferior, with the œsophageal ramuli of the cœliac axis.

(8.) *Arteriæ intercostales*—are separated from the sides of the aorta, and are commonly nine in number on each side; but they may be more or less, depending upon the number of intercostal spaces, supplied by the superior intercostal ramus of the subclavian artery. The intercostal arteries of the right side are longer than those on the left, and cross the bodies of the dorsal vertebræ behind the œsophagus, to gain their destination. They are not all separated from the aorta at the same angle—the superior forming an acute, while the inferior form an obtuse angle, with the aorta: the former to retard, the latter to facilitate the current of the blood. Their course and distribution are so similar, that a description of one of these vessels, will serve for the whole of them. They all pass behind the sympathetic nerves, and their ganglia; and on entering the space between the ribs and vertebræ, to which they belong, divide into two rami.

(A.) *Ramus dorsalis*—which directs itself backwards between the corresponding transverse processes of the vertebræ, is divided into superior, inferior, internal, and posterior ramuli.

The superior and inferior, to anastomose with the intercostal arteries above and below it; the internal, to pass through the intervertebral foramina, to supply the spinal marrow and its sheath; and the posterior, to expend themselves upon the muscles of the back.

(B.) *Ramus anterior, vel intercostalis proprius*—is much larger than the posterior ramus, and appears as a continuation of the main artery. It winds outwards and slightly downwards to gain the middle of the intercostal space, to be placed between the pleura and external intercostal muscles, where it soon divides into two small ramuli.

(*a.*) *Ramulus superior*—is the larger of the two, and runs along the acute edge of the rib above it, accompanied by a corresponding nerve and vein—the vein lies superior, while the nerve is inferior to it. At the anterior third, the inferior ramulus leaves the rib (hence no groove at this part of the bone), and is directed towards the middle of the intercostal space—supplying the intercostal muscles, pleura, and periosteum of the ribs. They terminate, those within the intercostal spaces of the ribs, by anastomosing with the ramuli intercostales of the internal mammary branch of the subclavian artery; and those of the false ribs, with the epigastric and circumflex iliac ramuli of the external iliac.

(*b.*) *Ramulus inferior*—is much smaller than the preceding, runs along the obtuse edge of the rib below it; and terminates, by supplying the outer surface of the ribs, and the muscles which cover them.

The superior aortic intercostal artery, anastomoses with the inferior subclavian intercostal ramus; and the inferior aortic intercostal artery, which is concealed by the pillars of the diaphragm, anastomoses with the first lumbar.

The posterior part of the thoracic aorta, sends off some small unimportant arteries to the cellular membrane within the posterior mediastinum.

The ABDOMINAL PORTION OF THE AORTA—extends from between the crura of the diaphragm to the junction of the fourth and fifth lumbar vertebræ, where it divides into the right and left common iliac artery. In this course it does not pass vertically, but with a degree of obliquity; being in the mesian line opposite the twelfth dorsal vertebra, and opposite the fourth lumbar; but between these points it inclines to the left of the bodies of the vertebræ, so as to present a concavity, facing to the right side. Again, its course is not vertical, owing to the form of the lumbar portion of the vertebral column; according with which, it is curved forwards, presenting its most anterior point on the third lumbar vertebra, a little above and to the left of the umbilicus.

The aorta, on leaving the thorax, does not immediately pass into the cavity of the abdomen, but is enclosed in a tendinous sheath, produced by the connecting fibres of the two cruræ of the diaphragm, and bounded behind by the last dorsal, and upper part of the first lumbar vertebra; so that, strictly speaking, this portion of the vessel is neither abdominal nor thoracic. The thoracic duct and vena azygos, pass through this opening, with the aorta between it and the right crus of the diaphragm. Directly the aorta has entered the abdomen, and is resting upon the first lumbar vertebra, it is covered by the lesser omentum, stomach, and solar plexus of nerves; and here gives off the diaphragmatic arteries, and the cœliac axis. Upon the second lumbar vertebra it is crossed by the vena portæ and pancreas; and immediately below the pancreas, by the duodenum; between which and the artery, the left emulgent vein is placed. In this extent the aorta next gives off the superior mesenteric, and the two emulgent arteries. Inferior to the junction of the second and third lumbar vertebræ, and below where the duodenum crosses the aorta to its termination, it is covered by the transverse mesocolon, and root of the mesentery—having the vena cava to its right side, with the continuation of the sympathetic nerve; while on the left side, it is also bounded by the sympathetic nerve, which is nearer to it in this situation.

The arteries that are given off from the aorta, within the abdomen, åre destined to supply the viscera and parietes of that cavity; and are separated, some in pairs and some in single branches, in the following order:—(9.) Arteria phrenica dexter; (10.) arteria phrenica sinistra; (11.) arteria vel axis cœliaca; (12.) arteria mesenterica superior; in the epigastric region. (13.) Arteriæ capsulares; (14.) arteriæ renales; (15.) arteriæ spermaticæ; (16.) arteria mesenterica inferior; in the lumbar region. (17.) Arteriæ lumbales; (18.) arteria sacra media; in the hypogastric region. The student cannot, however, dissect these vessels well in the above order of succession; but it is better first to examine the three azygos arteries, which supply the organs of digestion, and their assistants, the chylopoetic viscera: after which these organs being removed from the abdomen, the remaining vessels may be conveniently traced.

(11.) *Arteria vel axis cœliaca*—is a short vessel given off from the aorta between the crura of the diaphragm, upon the last dorsal vertebra. It is bounded above by the lobulus spigelii, and below by the pancreas; it directs itself forwards, and slightly to the right, for nearly an inch in extent, when it divides into three rami: ramus gastricus, vel coronarius ventriculi, ramus hepaticus, and ramus splenicus; but sometimes it gives off one or both of the phrenic arteries.

(A.) *Ramus gastricus, vel coronarius ventriculi*—is the smallest of the three branches given off from the cœliac artery. It takes its course upwards, forwards, and to the left; and having reached the lesser curvature of the stomach, it enters the space between the two layers of the lesser omentum; and arriving at the junction of the œsophagus with the stomach, it divides into two ramuli.

(*a.*) *Ramulus superior*—takes its course upwards upon the posterior surface of the œsophagus, which it supplies, anastomosing with the œsophageal arteries of the thoracic aorta: some ramusculi also pass downwards upon the great *cul de sac* of the stomach, supplying its coats, and anastomosing with ramuli of the splenic ramus.

(*b.*) *Ramulus inferior*—is the larger of the two, and takes its course along the lesser curvature of the stomach, from left to right, towards the pylorus, where it terminates by anastomosing with the ramulus pyloricus of the ramus hepaticus. In this course it sends off numerous ramusculi upon the anterior and posterior surface of the stomach, supplying that organ, and anastomosing with the left inferior gastric ramulus of the splenic ramus.

(B.) *Ramus hepaticus.*—To expose this vessel the liver must be raised, the anterior layer of the lesser omentum torn through, and the pyloric extremity of the stomach drawn downwards: it will then be seen to be a larger vessel than the preceding: directing itself forwards, upwards and to the right, towards the neck of the gall-bladder, and the transverse fissure of the liver;—upon entering which, and being placed before the vena portæ and behind the hepatic duct, it divides into two terminating ramuli; but previous to this division, it also sends off the following ramuli.

(*a.*) *Ramulus pyloricus*—is separated from the ramus hepaticus, rather above the pyloric extremity of the stomach, along which it runs, distributing ramusculi to it, and to the pancreas; it then terminates in a ramusculus which is directed along the lesser curvature of the stomach from right to left, and anastomoses with the ramulus inferior of the ramus coronarius.

(*b.*) *Ramulus gastricus inferior dexter*—arises behind the pylorus, from the under part of the ramus hepaticus, takes its course downwards, behind the pyloric extremity of the stomach and pancreas, and then proceeds from right to left along the greater curvature of the stomach, and terminates by anastomosing with the left inferior gastric ramulus. In this course it sends off, while in a vertical position behind the pyloric extremity of the stomach, ramusculi which are directed to the right, to supply the duodenum and posterior surface of the pancreas; and to the left, to the inferior and posterior surface of the pylorus. While it is passing along the greater curvature of the stomach, it sends ramusculi superiorly upon the anterior and posterior surface of that organ, and which anastomose with the ramulus pyloricus of the hepatic ramus; also descending branches to supply the two laminæ of the great omentum upon which they pass, and the transverse arch of the colon. The ramus hepaticus also sometimes before it divides, sends ramuli separately to the pancreas, duodenum, and stomach; but which are most frequently supplied as above described.

(*c.*) *Ramulus hepaticus dexter*—continues its course from between the vena portæ and hepatic ducts, along the transverse fissure of the liver; at the right extremity of which it enters into the substance of the right lobe, to be ultimately distributed in that organ. Before it is thus divided, however, it sends off—

(*α.*) *Ramusculus cysticus.*—This small vessel runs along the duct of the gall-bladder to the neck, and from thence distributes itself to the coats of that organ.

(*d.*) *Ramulus hepaticus sinister* — is smaller than the right hepatic ramulus: it proceeds obliquely upwards, to enter the transverse fissure of the liver; and taking its course to the left extremity of that fissure, it enters the left lobe, in which it is distributed, accompanying the ramifications of the vena portæ.

(c.) *Ramus splenicus.* — In the adult this is a larger ramus than the hepatic, but the reverse occurs in the fœtus. To gain a proper view of this branch, the stomach should be separated from the œsophagus and turned down, when its whole extent may be seen reaching from the cœliac axis to the spleen, in which it is distributed. It passes from right to left, forming numerous tortuosities, being lodged in a groove in the upper edge of the pancreas, accompanied by its corresponding vein, which is inferior to it. In this course it first sends off—

(*a.*) *Ramuli pancreatici*—the number of which is irregular. They pass from the lower part of the ramus to supply the parenchyma of the pancreas, in the substance of which they anastomose with the pancreatic ramifications of the ramulus gastricus inferior dexter. One of these ramuli, to the left extremity of the pancreas, is not unfrequently so much larger than the rest, that it has been denominated by some anatomists as the ramulus magnus pancreaticus.

(*b.*) *Ramulus gastricus inferior sinister* — when first separated from the splenic ramus, takes its course upwards and to the left of the great extremity of the stomach, behind which it is concealed: it then descends; and between the two layers of the great omentum, takes its course along the greater curvature of the stomach, to anastomose with the right inferior gastric ramulus. In its course it sends off small ramusculi to the pancreas, and ascending ramusculi to the anterior and posterior surfaces of the stomach, which anastomose with the descending ramifications of the ramulus inferior of the ramus coronarius ventriculi. Its descending ramusculi supply the left half of the great omentum, and the transverse arch of the colon.

(*c.*) *Ramuli breves.*—These are short vessels, separated from the splenic ramus just before it terminates within the spleen, and pass to the *cul de sac* of the stomach, which they supply; being directed upwards to the cardiac termination of the œsophagus, to anastomose with the œsophageal ramifications of the superior ramulus of the ramus coronarius.

The ramus splenicus then terminates by its ultimate distributions within the spleen.

(12.) *Arteria mesenterica superior*—is separated from the aorta not more than three or four lines distance below the celiac artery, and opposite to the first lumbar vertebra:

from hence it extends to the right iliac fossa, where it terminates by supplying the cœcum. In this course it forms a convexity facing to the left, and a concavity to the right. It is first covered by the pancreas and vena portæ; then emerging from the lower edge of the pancreas, it passes in front of the third portion of the duodenum, behind the transverse arch of the colon, and enters between the two layers of the mesentery, to pass to its terminations.

To expose this artery in its whole course, the transverse arch of the colon, with its mesocolon, must be turned upwards towards the thorax, when it may be seen passing from under the pancreas; and in consequence of the transparancy of the anterior layer of the mesentery, may be easily traced in the remainder of its extent.

Immediately after the mesenteric artery is separated from the aorta, it gives off some very small vessels to the duodenum and pancreas, which anastomose with the splenic and hepatic ramuli; after which, from its concavity, it sends off the three following rami.

(A.) *Ramus colicus superior dexter*—arises from the anterior and right portion of the mesenteric artery, while it is covered by the transverse mesocolon, between the two laminæ of which it insinuates itself, and runs forwards to near the middle of the arch of the colon; but before it reaches that intestine, it divides into a right and left ramulus.

(*a.*) *Ramulus anastimoticus sinister*—accompanies the left part of the transverse arch of the colon, as far as the junction of the arch with the descending colon, where it anastomoses with the ramus colicus superior sinister of the inferior mesenteric artery. From the convexities formed by these anastomoses, ramusculi pass off to supply the colon.

(*b.*) *Ramulus anastomoticus dexter*—is similar to the last, but takes its course in an opposite direction, to anastomose with the ramus colicus medius dexter, and in like manner gives off ramusculi, which supply the corresponding portion of the colon.

(B.) *Ramus colicus medius dexter*—arises generally about two inches below the last branch; sometimes, however, by a common trunk with it. It takes its course outwards, towards the ascending colon; but before it reaches it, divides into an ascending and descending anastomosing ramulus.

(*a.*) *Ramulus anastomoticus superior*—takes its course upwards, to anastomose with the right anastomotic ramulus, of the superior colic.

(*b.*) *Ramulus anastomoticus inferior*—takes its course downwards, to anastomose with the inferior right colic; both of them sending parallel ramusculi to the ascending colon from their convexities.

(C.) *Ramus colicus inferior dexter*—is the terminating branch of the superior mesenteric artery; it is directed between the two layers of the mesentery, to the junction of the ileum with the cæcum; just before it reaches this junction, however, it divides into three ramuli.

(*a.*) *Ramulus anastomoticus superior*—ascends to anastomose with the inferior anastomotic branch of the middle right colic.

(*b.*) *Ramulus anastomoticus inferior*—descends to anastomose with the termination of the superior mesenteric artery, and some of the branches from its convexity.

(*c.*) *Ramulus ileo colicus*—is the middle ramulus of the three; it runs from left to right to gain the posterior part of the colon and cæcum, where they are connected by the ileum—supplying the posterior parts of all these intestines.

(D.) *Rami mesentericæ.*—From the convexity of the superior mesenteric artery, from fifteen to twenty rami are given off, to supply all the small intestines excepting the two upper thirds of the duodenum. Their size and length diminish from above downwards; they are directed obliquely from right to left, and from above to below, between the two laminæ of the mesentery, toward the small intestines; before they reach them, however, they form numerous primary convexities, from which ramuli are distributed, that unite to form secondary convexities, from which ramusculi will sometimes form a third series of areolæ, before these vessels are finally distributed to the coats of the intestines.

(15.) *Arteria mesenterica inferior.*—This artery is separated from the aorta, much lower than the superior mesenteric artery, being not more than two inches from its division into the two iliacs, and opposite to the upper part of the fourth lumbar vertebra. It extends from that point deeply into the pelvis, where it terminates by supplying the rectum. In this course, like the superior mesenteric artery, it presents a concavity to the right, and a convexity to the left; but, unlike that vessel, it sends off its three principal branches from its convexity.

(A.) *Ramus colicus superior sinister*—is the largest of the three branches, and is usually separated from the inferior mesenteric artery, to the left side of the bifurcation of the aorta. It takes its course upwards, and having reached the anterior surface of the left kidney, it divides into two ramuli.

(*a.*) *Ramulus anastomoticus superior.*—This takes its course to the right, to anastomose with the ramulus anastomoticus sinister, of the superior colic ramus.

(*b.*) *Ramulus anastomoticus inferior* — descends, and unites in a similar manner, with the superior anastomotic ramulus, of the inferior left colic.

(B.) *Ramus colicus inferior sinister, vel sigmoideus*—directs itself outwards, and rather downwards to the left iliac fossa, to supply the sigmoid flexion of the colon ; when crossing the psoas muscle in this course, it frequently sends small ramuli to the ureter. Before it reaches the colon, it divides into a superior and an inferior ramulus; but sometimes also sends off a middle left colic ramulus.

(*a.*) *Ramulus anastomoticus superior*—passes to inosculate with the descending branch of the superior left colic.

(*b.*) *Ramulus anastomoticus inferior*—descends between the layers of the meso-rectum, and anastomoses with the superior hæmorrhoidal vessels.

(C.) *Ramus hæmorrhoidalis superior, vel internus*—is irregular in its origin, being sometimes separated from the inferior mesenteric artery in two or three branches. It passes downwards, crossing the left sacro-iliac symphisis, the ureter, and the iliac vessels; and becoming deeper seated, passes between the layers of the meso-rectum, along the posterior surface of the intestine. At about the centre of the sacrum, it divides into two equally sized ramuli, which descend along the sides of the rectum, and then dividing into numerous ramusculi, are distributed to the coats of the rectum as far as the anus. In this course it anastomoses with the middle, and external hæmorrhoidal vessels.

The organs of digestion, and the chylopoetic viscera, being now removed, the remaining arteries of the abdominal aorta may conveniently be traced.

Arteriæ phrenicæ—are very irregular both in their origin and division, not unfrequently arising by a single vessel, which soon divides into a right and left phrenic; at others, the right is a branch from the cæliac artery; and again, three or four vessels will arise from the cæliac artery and aorta.

(9.) *Arteria phrenica dexter* — is given off from the aorta, immediately as it emerges from the crura of the diaphragm; it ascends outwards, behind the superior cava, and along the free edge of the crus of the diaphragm; and having gained the posterior edge of the cordiform tendon, it divides into an anterior and external ramus; before this division, however, it sends off small ramuli to the right crus of the diaphragm, and others to the renal capsules.

(A.) *Ramus anterior dexter*—passes forwards to the opening of the œsophagus, around which it inosculates with a similar branch of the left phrenic artery, and sends some ramuli upon the œsophagus, which anastomose with the œsophageal ramuli of the thoracic aorta. It also sends ramuli through the diaphragm, which supply the pericardium; while others supply the diaphragm itself, anastomosing with the superior diaphragmatic ramuli of the internal mammary.

(B.) *Ramus externus dexter*—is directed transversely outwards, above the right lobe of the liver, and takes its course along the ribs to supply the digital origins of the diaphragm from those bones; and terminates by anastomosing with the inferior intercostal, and superior lumbar arteries; it also sends some very small ramuli to the capsula renalis of its own side.

(10.) *Arteria phrenica sinister*—is generally given off from the aorta, and ascends outwards, crossing in front of the corresponding crus of the diaphragm, which it supplies; it sends branches to the œsophagus, which are here larger than upon the right side, and three or four small rami to the left capsula renalis; after which it divides into its anterior and external rami, just posterior to the aponeurosis of the diaphragm. The rami take their course in a corresponding direction to those of the opposite side, and require therefore no separate description.

(13.) *Arteriæ capsulares.*—These vessels are distributed to the capsulæ renales, in three distinct sets—a superior, a middle, and an inferior. The superior are ramuli, from the arteriæ phrenicæ; the inferior, from the arteriæ renales; but the middle set, which we are now about to describe, arise immediately from the aorta.

At the fœtal period of life, they are nearly as large as the renal arteries, and arise immediately above them; but at the adult period, they are comparatively small, and unimportant. As they pass outward from the aorta, crossing the crura of the diaphragm, they send some small rami to them, and to the psoas muscle, and terminate in the organization of the capsulæ renales.

(14.) *Arteriæ renales, vel emulgentes*—are of a large size, being computed to convey one-eighth of the whole of the blood to the kidneys. They are given off from the aorta, below the superior mesenteric artery, about opposite to the interspace of the second and third lumbar vertebræ. The right renal artery is generally a little lower than the left, and longer, having to pass behind the vena cava, being covered by its corresponding vein. The left renal artery is a little more anterior than the right; and, like the right, is covered by its accompanying vein.

Before these arteries arrive at the kidneys, they send off—

(A.) *Rami capsulares inferiores.*—These are small vessels, which pass upward and outward, to the lower surface of the capsulæ renales, to which they are distributed.

The renal arteries then divide into three, four, or more rami, which approach the kidney between its pelvis, and the veins; but just as they enter the substance of the gland, they become anterior to the veins; where they subdivide, and are distributed to the parenchyma of the gland.

(15.) *Arteriæ spermaticæ*—in proportion to their length are the smallest, longest, and most tortuous arteries in the body. They are sometimes on both sides given off from the renal, more frequently on the right side only, but generally they are both given off from the aorta, above the inferior mesenteric artery, and below the renals, not usually upon the same level, but frequently at various distances one above the other. They take their course downward and outward, accompanied by their veins, and spermatic plexus of nerves; crossing the psoæ muscles, and the ureters,—to the outer side of which they descend, behind the peritoneum, to gain the internal abdominal ring; where, in the male, they become connected with the vasa deferentia, and assist in forming the spermatic cord in their descent to the testicle, where they terminate by dividing into two sets of rami—one of which goes to the epididymis, and the other to the bodies of the testicle, where they are finally distributed in the organization of the gland.

Where these vessels cross the ureters, they distribute small branches to the coats of those ducts.

In the female, the spermatic arteries arise as in the male subject, and take the same course into the cavity of the pelvis; instead of leaving which, they are received between the laminæ of the broad ligament of the uterus, to pass to the ovaria, into which they are finally distributed. One or two small branches, however, take the course of the round ligament of the uterus, pass into the inguinal canal, and are distributed to the labia, and mons veneris.

(17.) *Arteriæ lumbales*—arise from the posterior and lateral parts of the aorta. There are usually five pair, but the fifth not unfrequently takes its origin from the common iliacs. These arteries resemble the intercostals in their distributions, and pass off transversely from the aorta. Soon after their origin, when opposite the transverse processes of the vertebræ, they divide into three sets of rami.

(A.) *Rami spinales*—pass through the intervertebral foramina to the spinal canal, and send off ramuli to the posterior parts of the vertebræ, which anastomose with each other, and with the second set of rami.

(B.) *Rami posteriores*—are the second set, and are distributed to the lumbar muscles of the back; anastomosing with each other, with the intercostal arteries, and with the ramuli spinales.

(C.) *Rami anteriores*—the third set, are the largest, and appear as the continuation of the main artery.

The anterior rami of the first pair, direct themselves outward over the body of the first lumbar vertebra, immediately beneath the last rib, in the direction of the external circumference of the diaphragm; they then pass downward, to be finally distributed in the transversi abdominalis muscles.

The anterior rami of the second pair, are distributed to the quadrati lumborum muscles.

The anterior rami of the third pair, are larger in size than the preceding; they pass between the quadrati lumborum, and transversi abdominalis muscles, directing themselves toward the crista of the ilium, at the posterior third of which, they divide into two ramuli—both of which penetrate the origin of the muscles from the ilium, and pass downward along the gluteal muscles, which they supply, and anastomose with the gluteal ramifications.

The anterior rami of the fourth pair, direct themselves transversely outward, between the psoæ and quadrati lumborum, to pass to the crista of the ilium; where they divide into ramuli, which pass over the ilium to anastomose with the circumflexus ilii, and gluteal ramifications; and a branch passes to the abdominal muscles, which are supplied by the anterior ramusculi of all the anterior rami of the lumbar arteries. The superior ones anastomose with the intercostals; the inferior, with the ilio lumbar, and circumflexus ilii; and the middle, with the internal mammary, and epigastric rami.

(18.) *Arteria sacra media*—is the last artery given off by the abdominal aorta, before it divides into the two common iliacs, usually from its posterior surface, above its division, and opposite to the fourth lumbar vertebra; from thence it extends to the extremity of the os coccygis. In this course it passes in a tortuous direction along the centre of the anterior surface of the sacrum, behind the rectum and the superior hæmorrhoidal vessels. It gives off rami to the rectum, sacrum, and muscles within the pelvis, and anastomoses with the ilio lumbar, and lateral sacral ramuli of the ramus iliacus internus; it also sends some small rami through the anterior sacral foramina, to supply the spinal marrow.

(19.) *Arteriæ iliacæ communes*—are the two large arteries by which the abdominal aorta terminates. This bifurcation takes place at the intervertebral substance, between the fourth and fifth lumbar vertebræ; from which the common iliacs extend, diverging as they pass downward, as far as the sacro iliac symphysis, where they divide into the external and internal iliacs. The common iliacs are of equal size, separating from each other so as to form an acute angle with respect to themselves, and each an obtuse angle with the aorta.

From the greater breadth of the pelvis in the female than in the male, these arteries are, in them, separated wider in proportion. As their relative position differs with the surrounding parts, it will be necessary to describe them separately.

The *right common iliac artery*—is rather longer than the left; and in its course to the sacro-iliac symphysis, it crosses in front of the left common iliac vein, and the commencement of the inferior cava. It is crossed by the ureter anteriorly, and generally by the vermiform process of the cæcum; to the right, it is bounded by the cæcum, and the termination of the small intestines.

The *left common iliac artery*—descends with less obliquity to its termination than the right; its accompanying vein is internal, and posterior to it; the ureter and rectum cross it in front; and the sigmoid flexure of the colon is placed to its left. Neither of these arteries, before their division at the sacro-iliac symphysis, send off any important branches; some of a minute size may, however, be traced to the peritoneum, glands, and muscles within the pelvis.

The common iliac arteries, are destined to supply the pelvis, both externally and internally, as well as the whole of the lower extremity: it is therefore divided, at the adult period of life, into equally sized vessels; at which time, the external iliac artery appears to be a continuation of the main trunk; but if examined in the fœtal period of life, the internal iliacs are the more important, and perform the office of conveying the refluent blood to the mother, when they seem to be the continuation of the main trunk. Therefore we shall consider them both as continuations of the common iliac arteries, numbering them the same; but under the names they assume in the different situations they pass through; in the same manner as we did the continuation of the subclavian artery to the bend of the elbow.

(19.) *Arteria iliaca interna, vel hypogastrica.*—The important office which this artery performs in the fœtal circulation, by conveying the blood to the placenta of the mother, is the occasion of its comparatively large size at that period. It takes its course from the division of each common iliac, downwards and forwards, to the back part of the bladder; from thence it ascends along the sides and superior part of the fundus, takes the course of the urachus, and passing between the peritoneum and fascia transversalis, reaches the umbilicus, and constitutes part of the umbilical cord—with which it is continued to the placenta.

While within the abdomen, it gives off some very minute rami to the surrounding parts; on passing through the opening of the umbilicus, it decreases in size, winds around the umbilical vein, and near the placenta frequently inosculates with its fellow from the opposite side, before the two vessels ramify within the placenta.

After birth, these arteries not being longer required, are filled with a coagulum, and become obliterated; at the same time, the external iliac and its branches increase in size, until they bear the same proportion to the main trunk, which the internal iliacs had done during fœtal life.

The internal iliac in the adult subject, takes its course from the division of the common iliac, nearly vertically to the cavity of the pelvis, in front of the sacro-iliac symphysis, to gain the sciatic notch, where it terminates by dividing into numerous rami. In this course it makes a curve with a concavity facing forwards.

The rami given off from this artery, may be divided into three sets: those which supply the muscles within the pelvis; those which supply the viscera within the pelvis; and those which pass out of the cavity of the pelvis.

As the dissection of these vessels is attended with some difficulty, a side view of the pelvis should be made, in order to expose them most conveniently.

The rami which supply the muscles within the pelvis, are two in number.

(A.) *Ramus ilio lumbalis*—arises from the posterior part of the internal iliac artery, in front of the sacro-iliac symphysis. It takes its course first upwards, then outwards behind the psoas and iliacus muscles; anterior to the communicating branch of the last lumbar nerve, and posterior to the anterior crural nerve, and external iliac artery and vein. Having reached the upper part of the sacro-iliac symphysis, it divides into three sets of ramuli.

(*a.*) *Ramulus ascendens*—behind the psoas and iliacus muscles, rises upwards upon the os ilium, as high as the posterior and superior spinous process, where it anastomoses with the inferior lumbar arteries; and some few ramusculi pass into the intervertebral foramina, to assist in supplying the spinal marrow; and, finally, it is distributed to the psoas, iliacus, and quadratus lumborum muscles.

(*b.*) *Ramulus descendens*—takes its course downwards, underneath the psoas and iliacus muscles; and descending in the substance of these muscles to the crural arch, anastomoses there with the epigastric rami of the femoral artery.

(*c.*) *Ramulus externus*—takes its course outwards upon the venter of the ilium, under the iliacus muscle; supplying both with blood, and passing outwards to the crista of the bone, terminates by anastomosing with the ramus circumflexus ilii, arteriæ femoralis.

(B.) *Ramus sacri lateralis.*—This branch is irregular, both as to its origin and number; arising, sometimes by three or four small vessels, at others in a single branch, commonly from the internal iliac, but occasionally from the ilio lumbar, or the gluteal ramus. When it arises in a single branch, it is directed downwards and inwards, along the anterior surface of the sacrum, external to the middle sacral artery; and converging in its descent as far as the os coccygis, it anastomoses with the corresponding ramus of the opposite side, and with the middle sacral artery. In this course, it crosses anterior to the pyriform muscle, and sacral nerves; the sympathetic nerve is placed to its inner side, between it and the middle sacral artery—it divides into two sets of ramuli.

(*a.*) *Ramuli posteriores*—are four or five in number, which pass into the anterior sacral foramina, and there divide into two sets of ramusculi—the exterior to supply the spinal marrow, and its membranes; while the posterior emerge from the spinal canal, through the posterior sacral foramina, and terminate by being distributed to the neighbouring deep-seated muscles of the back.

(*b.*) *Ramuli interni*—are far less important than the preceding ramuli; they pass inward upon the anterior surface of the sacrum, and terminate by anastomosing with the branches of the middle sacral artery.

The branches to the viscera within the pelvis, are—

(c.) *Ramus hæmorrhoidalis medius.*—This ramus varies much, both in size and origin, and is even occasionally entirely wanting. Although it sometimes arises from the ischiatic or pudic rami, it most frequently comes from the internal iliac artery. It takes its course downwards, forwards, and inwards, upon the anterior surface of the rectum, between it and the bladder, in the male, but between it and the vagina, in the female; in either of these situations it divides into superior and inferior ramuli: the superior anastomosing with the internal hæmorrhoidal ramus of the inferior mesenteric artery; and the inferior anastomose with the external hæmorrhoidal ramulus of the internal pudic ramus. It also supplies, in both sexes, parts of the organs of generation; namely, the prostate gland, and vesiculæ seminales, in the male, and the vagina and uterus, in the female.

(D.) *Rami vesicales.*—The bladder receives its blood from three distinct sources, the vessels may therefore be arranged in three sets; the superior, from the umbilical branch, from which point, that vessel is obliterated after birth; the inferior from the hæmorrhoidal, internal pudic, and sciatic branches; but the middle set, are the rami vesicales, which we are now about to describe, as they most generally arise from the internal iliac, and sometimes only by one single vessel.

From its origin, it passes forwards, accompanying the ureter, until it reaches the bladder; where it divides into numerous ramuli, supplying the under surface of the bladder; and in the male, distributing itself to the prostate gland, vesiculæ seminales, vasa deferentia, and commencement of the urethra.

(E.) *Ramus umbilicalis.*—This vessel assumes a very different character after the fœtal period. Before birth, it is a large branch, and seemingly a continuation of the internal iliac artery; and runs upwards to the umbilicus, in a manner which has already been described in its passage to the placenta. After birth, the whole vessel diminishes very much in size, but still conveys some small quantity of blood as far as the bladder; beyond which, it assumes the appearance of an impervious cord—described by some anatomists, as a ligament of the peritoneum.

(F.) *Ramus uterinus.*—The size of this artery depends upon the age of the individual, and the state of developement of the uterus; increasing with the size of that organ during uterine gestation, until it becomes the largest of the branches of the internal iliac. It it various in its origin, being sometimes given off from the internal pudic; it directs itself forwards to the upper part of the vagina, and passing between the two layers of the broad ligament in a very tortuous course, it reaches the uterus: here it divides into numerous ramuli, which ramify through the parietes of the uterus, anastomosing in its substance with the other vessels of that organ.

This ramus also supplies in part the bladder and vagina; and while between the broad ligaments, it sends ramuli to the fallopian tubes and ovaria; anastomosing with the spermatic artery from the abdominal aorta.

(G.) *Ramus vaginalis*—is very various in its origin, and is sometimes wanting, when the vagina is supplied by ramifications from the branches of other arteries proportionably increased in size. Arising from the internal iliac, it directs itself forwards to the lateral surface of the bladder, to which it sends some small ramuli; then reaching the side of the vagina, it ramifies on its parietes, proceeding as far as the external organs of generation, in which it terminates.

The third set of the ramuli of the external iliac, and which pass out of the pelvis, are—

(H.) *Ramus obturatorius.*—This vessel, like the branches already described of the internal iliac, is various in its origin; sometimes springing from the gluteal, ischiatic, or epigastric branch of the femoral artery: the latter, although not uncommon, must be considered curious from its altering entirely the course of the vessel, and rendering its pathological consideration highly important, particularly as connected with femoral hernia.

When it arises from the internal iliac, it passes forwards and downwards along the linea ilio pectinea, on the inner side of the psoas and iliacus muscles, and above the levator ani, until it reaches the upper edge of the obturator internus muscle, which it penetrates, and then passes through the obturator ligament, to descend into the thigh. The vessel in this course is accompanied by a corresponding nerve, which is anterior to it. While within the pelvis, the obturator artery gives off—

(*a.*) *Ramuli interni*—which are distributed to the absorbent glands, situated around the iliac vessels; and also supply the psoas, iliacus, levator ani, and obturator internus muscles. The bladder, and organs of generation within the pelvis, frequently receive ramuli from the obturator ramus.

Just before it passes through the obturator ligament, it sends a ramulus along the inner edge of the obturator foramen, which passes upwards towards the symphisis pubis, and inosculates with a similar branch of the opposite side: from which union ramusculi pass upwards upon the abdominal muscles, and anastomose with the epigastric ramus. As soon as the obturator ramus leaves the pelvis, it sends off its—

(*b.*) *Ramuli externi*—which divide into two sets of ramusculi. The first of these pass downward and outward, along the outer margin of the obturator foramen: and winding beneath the acetabulum, between it and the tuberosity of the ischium, divide into several ramifications, to supply the obturator externus muscle, and to pass through the cotyloid foramen into the interior of the joint to the capsular ligament: they also supply the numerous posterior muscles of the thigh, among which they anastomose with the internal circumflex ramulus of the ramus profundus, and with the ischiatic and pudic rami of the internal iliac artery.

The second external ramulus takes its course backwards and inwards, under the obturator externus muscle, to the inner margin of the obturator foramen, where it is covered by the obturator externus, pectineus, and adductors of the thigh, and then divides into numerous muscular ramusculi, anastomosing with the internal circumflex branch of the ramus profundus. Some of its ramusculi penetrate the adductor muscles; and passing to the perineum and scrotum, anastomose with the internal pudic ramus of the internal iliac artery. Some other ramusculi pass downward, beneath the gracilis, and adductor longus muscles, and inosculate with the perforating ramuli, of the ramus profundus, of the femoral artery.

(I.) *Ramus gluteus vel iliacus posterior*—is the largest of the branches from the internal iliac artery. It takes its course outwards, downwards, and backwards, above the pyramidal muscle, to pass out of the great sciatic notch, being accompanied by its corresponding vein, and superior gluteal nerve. At its origin it is covered by the internal iliac artery and vein, and by a communicating branch of the last lumbar, and first sacral nerve. When it has passed out of the notch, and gained the dorsum of the ilium near the posterior edge of the gluteus minimus muscle, it terminates by two ramuli. While the ramus gluteus is within the pelvis, it but rarely distributes any important branches; but sometimes the ilio lumbar, lateral sacral, and middle hæmorrhoidal ramus arise from it. Where it passes through the ischiatic notch, it distributes a few ramuli to the pyriform muscle; and while on the dorsum of the pelvis, covered by the gluteus maximus, it divides into its two terminating ramuli, by which it performs its most important office.

(*a.*) *Ramulus superficialis.*—To expose this vessel, the gluteus maximus must be raised, when it will be seen directing itself outwards, between the gluteus maximus, and gluteus medius muscles, and separating into numerous ramusculi, some of which supply the glutei muscles, others pierce the posterior sacro sciatic ligament, to ramify on the back part of the sacrum, and os coccygis, and anastomose with the ramuli of the pudic, sciatic, and lateral sacral rami.

(*b.*) *Ramulus profundus*—is larger than the preceding. It passes upwards and forwards, between the gluteus medius and minimus; and having sent off—

(*α.*) *Ramusculus nutritius*—to the ilium, immediately divides into three sets of ramusculi.

(*β.*) *Ramusculi superiores*—usually two or three in number—take their course forward, along the upper convex edge of the gluteus minimus muscle, and continue as far as the anterior superior spinous process of the ilium, where they terminate by anastomosing, with the circumflex ramuli of the femoral artery; but in their course they send ramifications to the gluteus medius, and gluteus minimus muscles, and anastomose with the ilio lumbar, and circumflex ilii rami.

(*γ.*) *Ramusculi medii*—usually two vessels, take their course downward, and outward, toward the trochanter major, crossing the centre of the gluteus minimus, in the direction of the fibres of that muscle. They are covered by the gluteus medius, which they supply with ramifications, as well as the gluteus minimus; and terminate by anastomosing, underneath the tensor vaginæ femoris muscle, with the external circumflex ramuli, of the femoral artery.

(*δ.*) *Ramusculus inferior*—or descending ramusculus, passes downwards in the same course as the last described; but is deeper seated, as it perforates the gluteus minimus muscle, and lies upon the dorsum of the ilium. It then passes forwards, above the acetabulum, to the anterior and inferior spinous process of the ilium, where it terminates as the others, by anastomosing with the external circumflex ramulus of the femoral artery. It also supplies the gluteus medius and minimus muscles, and origin of the rectus.

The frequent anastomosis of the ramifications of the gluteal ramus from the internal iliac, with the circumflex ramuli of the femoral artery, renders this vessel highly important in obliterations of the external iliac artery.

(K.) *Ramus ischiadicus*—arises from the internal iliac artery, rather anterior to the separation of the gluteal ramus. It is smaller than that ramus, although more like a continuation of the artery from which it arises. It passes vertically downwards, in front of the pyriform muscle, between the inferior edge of which, and the anterior sacro-sciatic ligament, it passes out of the sciatic notch, in front of the sciatic nerve, and terminates by ramuli to the back part of the ilium and thigh. While within the pelvis, this ramus sometimes distributes ramuli to the viscera contained within the cavity, but this is very variable. As soon as it passes out of the pelvis, it is covered by the gluteus maximus muscle, and descends between the trochanter major, and tuberosity of the ischium, but nearer to the latter, and terminates in the back part of the thigh, by supplying the muscles of that region. In the above course it distributes three ramuli.

(*a*) *Ramulus coccygeus*—is a vessel of considerable size. It directs itself obliquely inwards, across the external pudic artery, which is anterior to it, perforates the origin of the sacro-sciatic ligaments, to gain the os coccygis and sacrum, where it anastomoses with the posterior ramuli, of the lateral sacral ramus.

(*b.*) *Ramulus comes nervi ischiadici*—as its name implies, takes its course with the ischiatic nerve as far as the inferior part of the thigh: in this course anastomosing frequently with the branches of the femoral artery.

(*c.*) *Ramuli musculares*—are separated from the ischiatic in the fossa between the tuberosity of the ischium and the trochanter major, and immediately divides into numerous ramusculi, to supply, anteriorly, the gemini, obturator internus, and quadrator femoris muscles, and anastomose with the circumflex ramuli of the ramus profundus; externally, the glutei at their insertion into the trochanter major; and inferiorly and internally, the biceps, semi-membranosus, and semi-tendinosus muscles, and anastomosing with the perforating ramuli of the ramus profundus. The ramus ischiadicus also assists in conveying blood from the internal iliac to the lower extremity, in cases of obliteration of the external iliac artery.

(L.) *Ramus pudicus internus*—generally arises from the internal iliac artery, immediately after the separation of the ramus ischiadicus; but the two will sometimes arise in common; in which case, they may not separate into two branches, until the common branch has passed out of the pelvis. When it arises separately from the internal iliac, it descends vertically in front of the ischiatic nerves and pyramidal muscle, and passes out of the pelvis below the inferior edge of the pyramidal muscle, accompanied by the ischiatic artery, which is anterior and internal to it.

In the second part of its course, it is placed between the pyramidal muscle and the posterior sacro-sciatic ligament, on the dorsum of the pelvis, forming an arch, the concavity of which embraces the spinous process of the ischium, and insertion of the anterior sacro-sciatic ligament.

In the third portion of the course of this ramus, it re-enters the pelvis, between the two sacro-sciatic ligaments, running forwards on the inner side of the tuberosity and ramus of the ischium and pubis, as far as the symphysis pubis, where it terminates by dividing into two ramuli.

In the first part of the course of the ramus pudicus internus, namely, while within the pelvis, it sometimes gives off the ramus hæmorrhoidalis medius, but always small ramuli to the bladder and organs of generation, both in the male and female.

In the second part of its course, namely, while exterior to and on the dorsum of the pelvis, it distributes small ramuli to the sacro-sciatic ligaments, to the tuberosity of the ischium, to the sacrum, to the os coccygis, and to the muscles arising from the bones; it also anastomoses with the ischiatic and gluteal rami. This portion of the artery is covered by the gluteus maximus muscle.

In the third part of its course, namely, where it re-enters the pelvis, this ramus is of great practical importance. It first lies between the obturator internus muscle, which separates it from the bone, and the junction of the obturator fascia with the sacro-sciatic ligament, which excludes it from the cavity of the pelvis; it then proceeds forwards, along the ramus of the ischium and pubes, to the triangular ligament, where it terminates. In this course it sends off—

(*a.*) *Ramuli hæmorrhoidales externi*—are usually separated from the external pudic ramus directly it has re-entered the pelvis: they pass inward, penetrating the obturator fascia, and then only are properly within the cavity: they here supply the levator ani muscle, and some of them perforate it, to supply the sides of the rectum, and anastomose with the ramus hæmorrhoidalis medius of the external iliac artery.

(*b.*) *Ramulus perenæi*—Takes its course forwards, to perforate the deep fascia of the perinæum, which in fact is continuous with the obturator fascia of either side, reaching across from the rami of the ischium and pubis of one side, to the other. After perforating this fascia, it is placed within the perinæum, and continues its course forwards and inwards towards the symphysis pubis: having to its outer side the erector penis, and on its inner side the accelerator urinæ muscle.

In the first part of this course, it is very deeply seated, and is nearer to the tuberosity of the ischium than to the centre of the perinæum; but as it advances, it becomes more superficial, and approaches the mesian line. In this extent it sends off internal ramusculi, to supply the muscles of the perinæum, and to anastomose with the corresponding ramulus of the opposite side. It sends also external ramusculi around the rami of the ischium and pubes, to anastomose with branches of the femoral artery, upon the inner side of the thigh; and it terminates anteriorly, by small ramusculi, which supply the scrotum. The whole course of this ramulus, is accompanied by a branch of the internal pudic nerve.

(*c.*) *Ramulus transversalis perinæi*—is smaller than the last described vessel, and is indeed very frequently a ramusculus from it. When arising from the internal pudic, it is anterior to the ramulus perinæi, and perforates the deep fascia of the perinæum, passing as far forwards as the transversus perinæi muscle; having gained which, it runs upon the under surface of that muscle inwards towards the mesian line, where it anastomoses with the corresponding ramulus of the opposite side; posteriorly, with the external hæmorrhoidal ramulus; and anteriorly, with the perineal.

(*d.*) *Ramulus corporis bulbosi, vel spongiosi urethræ*—is a larger vessel than any of the other ramuli of the pudic ramus, but takes a much shorter course; it does not, like the ramuli of the perinæum, perforate the deep fascia, but passes within the anterior layer of that membrane, as it passes forwards to cover the membranous portion of the urethra and bulb. When the ramulus reaches the bulb, it divides into two ramusculi; the smaller of them descends a little to supply Cowper's gland of its own side; while the largest enters the bulb, and supplies it, and the corpus spongiosum urethræ. It is this vessel which frequently leads to fatal hæmorrhage, after the operation of lithotomy.

(*e.*) *Ramulus corporis cavernosi penis*—is one of the vessels by which the internal pudic terminates, after it has perforated the triangular ligament of the pubes, and is placed between the bone and the crus of the penis. This ramulus enters the crus penis, and runs through it into the corpus cavernosum of its own side, where it divides into numerous ramusculi, which open into the cells of the organ. Some of them anastomose in the mesian line, passing through the septum to the corresponding vessels of the opposite side; others supply the lining membrane of the urethra.

(*f.*) *Ramulus dorsalis penis*—appears like a continuation of the internal pudic ramus; it takes its course outside the crus, between it and the ramus of the pubes; and running superficially under the integuments, accompanied by its corresponding vein and nerve, it approaches the ramulus of the opposite side, running in a groove upon the dorsum of the penis, as far as the corona glandis, where the two ramuli inosculate. In this course it sends off ramusculi to the scrotum, and to the skin and fascia of the penis. At the earlier periods of life, the internal pudic ramus and its divisions bear but a small proportion to their developement at the adult period.

(19.) *Arteriæ iliacæ externæ*—are continuations of the common iliac arteries, as are the internal iliacs, to which they bear a proportionable size, differing at different periods of life. If examined at the adult period, they are found larger than the internal iliacs, and seem to be a continuation of the common iliacs; while, as has been already stated, before birth they are small and comparatively unimportant vessels. The extent of the external iliac arteries, is from the sacro-iliac symphysis to the lower edge of Poupart's ligament, from whence they change their name, being successively denominated femoral, and popliteal, from the regions through which they pass. The course, boundaries, and distribution of each external iliac, are so precisely similar, that the description of one will serve for both.

In the passage from their separation to their termination at Poupart's ligament, they descend obliquely outward, along the inner edge of the psoas muscle, to which they are loosely connected by a portion of the fascia iliaca; this fascia also unites the arteries with their corresponding veins, which are placed to their inner side, and rather posterior to them above; but on the same plane with them below, as they pass over the pubes. They have also behind them the psoas, and the tendinous portion of the iliacus muscle; in front, the peritoneum, and a branch of the external spermatic nerve; and on their outer side, the anterior crural nerve, which is, however, on a plane posterior to them, being behind the fascia iliaca, while the arteries are in front.

In this course, the external iliac artery is sometimes curved: it sends off some small rami, to be distributed to the psoas and iliacus muscles, and the deep inguinal glands; they are however, small and unimportant compared to the two following rami.

(A.) *Ramus epigastricus*—is sent off from the inner side of the external iliac artery, usually close to the external abdominal ring, but behind the fascia transversalis, between it and the peritoneum. The variations in this origin, are, that it is sometimes given off an inch above Poupart's ligament; at others, immediately at its lower edge: in the former case, the vessel descends first, before it can turn up in front of the peritoneum; but in the latter, it immediately ascends.

This ramus extends from a little to the inner side of the centre of Poupart's ligament to the umbilicus, crossing behind the spermatic cord, from which it is separated by the fascia transversalis. The vas deferens, however, having reached the internal ring, leaves the spermatic cord, and passes behind the epigastric artery to reach the prostate gland.

When the ramus epigastricus reaches the rectus muscle, midway between the pubes and umbilicus, it perforates the sheath of the rectus, and then becomes separated from the peritoneum. In this course, it frequently gives off the ramus obturatorius, which has then to pass backwards and inwards to gain the obturator foramen; under which circumstance, should a femoral hernia pass down behind it, and become strangulated, in the separation of the stricture, it must almost necessarily be divided, in the event of an operation.

It sends off ramuli, which penetrate the fascia transversalis to gain the inguinal canal, to supply the cremaster muscle and tunica vaginalis, anastomosing with the spermatic arteries. In the female, these ramuli take the course of the round ligament of the uterus. As the ramus epigastricus ascends, it sends off numerous ramuli externally, to supply the abdominal muscles; and anteriorly, through the tendon of the external abdominal oblique, to supply the skin and fascia, anastomosing with the external epigastric of the femoral artery: lastly, when it has reached the sheath of the rectus, it sends some ramuli upward, to anastomose with the internal mammary ramus of the subclavian artery; and inward, to anastomose with the corresponding ramus of the opposite side; and outward, to anastomose with the lumbar arteries and ramus circumflexus ilii.

(B.) *Ramus circumflexus ilii*—is usually smaller than the preceding branch, and is sent off lower down from the external side of the external iliac. It ascends upwards and outwards, crossing the iliacus and psoæ muscles to gain the crista of the ilium; having reached which, it divides into two ramuli, one external and one internal.

(*a.*) *Ramulus anterior*—ascends between the transversalis and internal abdominal oblique muscles, to be distributed to them.

(*b.*) *Ramulus posterior*—is the larger, and take its course along the inner labium of the crysta of the ilium, over which it anastomoses with the superficial ramuli of the ramus gluteus; it still continues its course backwards and upwards to terminate in the abdominal muscles, anastomosing with the ilio lumbar, the lumbar, inferior intercostal, and internal mammary vessels.

(19.) *Arteria femoralis*—commences from the external iliac, immediately as it emerges from the lower edge of Poupart's ligament; and extends to the junction of the middle with the inferior third of the thigh, at the point where the adductor magnus muscle becomes tendinous, through which it passes, and is then named the popliteal artery. In this course, the femoral artery may be divided into an upper and a lower half; the former being placed superficially, and in front; and the latter deeply seated, and on the inner side of the thigh; from which it results, that its course is oblique from above downwards.

The superior half is covered by integuments, superficial fascia, absorbent glands, and the fascia lata. It lies upon the pectineus, adductor brevis, and adductor longus muscles; from the two former, however, it is separated by an interval of cellular membrane, excepting in certain positions of the thigh. It is bounded, externally and above, by the anterior crural nerve; then by the tendons of the psoas and iliacus, which separate it from the hip-joint; and below this, by the vastus internus muscle, and sartorius—which are, however, at some distance from it. Internally, it has to its inner side above, the femoral vein; but which, as it descends, gets behind the artery.

The femoral artery commences its lower half, where the sartorius muscle crosses it and the adductor longus, forming the apex of a triangle, in the centre of which the upper half of the femoral artery is placed. The lower portion of the artery is covered by the skin, fascia lata, and sartorius muscle; behind which will be found a fascia, common to the vastus internus and adductor longus muscles, in which the artery, vein, and the nervus saphenus are enclosed. Posteriorly, it is bounded by the conjoined tendons of the vastus internus and adductor muscles; externally, by the vastus internus; and internally, by the adductor magnus. The branches which are sent off from the upper half of the femoral artery, are four in number—three of which are superficial, and one deep.

(A.) *Ramus epigastricus superficialis*—arises about half an inch below Poupart's ligament; it almost immediately penetrates the fascia lata, ascends above Poupart's ligament, taking the direction of the internal epigastric artery, but being merely subcutaneous. It extends from below Poupart's ligament, nearly to the umbilicus, where it terminates by anastomosing with small branches of the deep epigastric, and internal mammary rami. In this course, immediately after its origin, it supplies the inguinal glands; and having reached the abdomen, it there supplies the skin, and the abdominal muscles.

(B.) *Ramus pudicus superficialis*—usually two in number, a superficial, and a deep branch; but often it arises by a common vessel, which afterwards divides.

(*a.*) *Ramulus superficialis*—takes its course upwards and inwards to the pubes, to supply the external organs of generation in both sexes, and to anastomose with ramusculi of the internal pudic.

(*b.*) *Ramulus profundus*—which is sometimes sent off from the ramulus circumflexus internus, takes its course in a transverse direction, behind the fascia lata, and in front of the pectineus muscle, to gain the perinæum, in which it terminates, anastomosing with the ramus pudicus internus.

(c.) *Ramus circumflexus ilii superficialis*—is much smaller than either of the other branches; and although pretty constant in its origin and course, is not particularly described by anatomists. Immediately after its origin it pierces the fascia lata, takes its course outwards, along the under edge of Poupart's ligament, as far as the spinous process of the ilium; where it divides into numerous ramuli, to supply the parietes of the abdomen, and to anastomose with the deep circumflexus ilii, gluteal, and external circumflex rami.

(D.) *Ramus profundus femoris*—is separated from the posterior part of the femoral artery, usually about an inch and a half below Poupart's ligament; and in a space midway between the pubes and trochanter minor; from hence it passes downwards and backwards, to about the middle part of the thigh; where perforating the aponeurosis of the adductor longus, it gains the posterior part of the thigh, and terminates in three or four muscular ramuli.

In this course, the ramus profundus is first directed slightly outwards from the femoral artery, lying on the psoas and iliacus muscles; it then descends in front of the insertions of the pectineus and adductor brevis, and perforates the adductor longus, as before stated. It has in front of it, in the first part of its course, where it is directed outwards from the femoral artery, only the fascia lata and common integuments; but as it descends, it is covered by the femoral artery and vein, with which it runs parallel for some distance, but much deeper seated.

Five ramuli are sent off from the ramus profundus, which have distinct names; besides others, which are of less importance.

(*a.*) *Ramulus circumflexus externus* –is given off while the ramus profundus is to the outer side of the femoral artery; it is directed transversely outwards, and is a large short vessel, passing behind the rectus and sartorius muscles, and crossing in front of the psoas, iliacus, and cruræus, where it is divided into three sets of ramusculi.

(α.) *Ramusculi ascendentes*—are three or four in number, which run upward, behind the sartorius and tensor vaginæ femoris, and then between that muscle and the gluteus medius and minimus; anastomosing with the ramusculi inferiores, of the gluteal ramus; and terminate by supplying the neighbouring muscles.

(β.) *Ramusculi transversales*—are two or three in number, and continue in the direction of the main ramulus, passing still farther to the outer of the crureus muscle, as far as the origin of the vastus externus muscle, where they perforate it and the insertion of the gluteus maximus; and gain the posterior part of the thigh, below the trochanter major, where they terminate by supplying the muscles, and anastomosing with the ramulus circumflexus internus, and the gluteal and ischiatic rami.

(γ.) *Ramusculi descendentes*—are large and numerous they pass downward, between the crureus and vastus externus muscles, and extend to the outer side of the knee-joint, where they terminate by anastomosing with the articular ramuli of the popliteal artery. They also supply the rectus, crureus, and vastus externus; in their course anastomosing, posteriorly, with the perforating ramuli of the ramus profundus.

(*b.*) *Ramulus circumflexus internus*—is usually larger than the preceding ramulus, and is given off below it. It takes its course backwards and inwards, between the pectineus and the tendinous insertion of the psoas and iliacus muscles; it then continues its course around the neck of the femur, between the inferior edge of the quadratus femoris and the superior edge of the adductor magnus, where it divides into two terminating ramusculi. In this course, the ramulus gives off small ramusculi to the neighbouring muscles, the capsular ligament, and others anastomosing with the ramus obturatorius; they together supply the interior of the hip-joint.

(α.) *Ramusculus ascendens*—is separated in the space between the quadratus femoris and adductor magnus, and is covered, posteriorly, by the gluteus maximus. It then arises outwards, along the obturator externus muscle, to gain the digital cavity of the great trochanter, where it terminates by supplying the outer rotators of the thigh, and anastomosing with the gluteal and external circumflex ramuli.

(β.) *Ramusculus descendens*—is rather the larger of the two, and takes a transverse course downwards, dividing into two sets of ramifications; one set passing inwards to the tuberosity of the ischium, supplying the origin of the muscles of the ham-strings; the other passing downwards in the course of the sciatic nerve, to terminate by supplying the adductor magnus muscle, and anastomosing with the gluteal ischiatic rami, and the superior perforating ramusculus of the ramus profundus.

The frequent anastomoses of the circumflex ramuli with the gluteal, ischiatic, pudic, and obturator rami of the internal iliac artery above; and with the articular rami of the popliteal artery below, is the principal means of carrying on the circulation, in obliterations of the external iliac.

(*c.*) *Ramulus perforans primus*—is sent off from the ramus profundus, opposite to the trochanter minor; it takes its course backwards, below the tendon of the pectineus; and passing between the adductor longus and the adductor brevis, it perforates the adductor magnus, where it terminates in numerous ramusculi. In this course, it supplies the pectineus, and adductor muscles; afterwards the gluteus maximus and biceps; anastomosing, above, with the ischiatic, and gluteal rami, and the circumflex ramuli of the ramus profundus; and below, with the inferior perforating ramusculi,

(*d.*) *Ramulus perforans secundus*—is sent off immediately below the preceding ramulus, and directly perforates the adductor brevis, and then the adductor magnus, to gain the back part of the thigh; where it divides into ascending ramusculi, to supply the gluteus maximus muscle, and to anastomose with the ramulus perforans primus; and descending ramusculi, which supply the biceps, semi-membranosus, semi-tendinosus, and triceps muscles; and to anastomose with the ramulus perforans tertius. It sends also a ramusculus nutritius into the former; the foramen for which is directed from below upwards, and is usually found at about the junction of the upper with the middle third of the femur, in the course of the linea aspera..

(*e.*) *Ramulus perforans tertius*—is the smallest of the three ramuli, and is separated much lower down than the others. It passes to the back part of the thigh, perforating the adductor magnus, and immediately dividing into numerous ramusculi, which superiorly anastomose with the other perforating ramuli, inferiorly with the articular rami of the popliteal artery; and terminates by supplying the surrounding muscles.

(E.) *Ramus anastomoticus magnus*—is separated from the femoral artery, just where it enters the tendinous sheath formed for it by the tendons of the triceps and vastus externus muscles. It immediately perforates this fascia, and takes its course inwards, along the vastus internus, towards the inner condyle of the femur, where it divides into numerous ramuli; inferiorly, anastomosing with the articular rami of the popliteal artery, and with the recurrent branch of the anterior tibial ramus; superiorly, anastomosing with the ramusculi perforantes; and anteriorly, behind the extensor tendon of the knee-joint, with the descending ramusculi of the external circumflex ramulus.

(19.) *Arteria poplitea*—is so termed immediately the femoral artery emerges from the fascial sheath formed by the adductor magnus and vastus internus muscles; from this it passes obliquely downwards and outwards, to the lower edge of the popliteus muscle, where it terminates by dividing into two rami.

It may be observed, when taking a general view of the course of the femoral and popliteal arteries in the thigh, that the first third of this course is anterior, the middle third internal, and the lower third posterior, to the thigh-bone.

The lower third, or popliteal artery, is bounded, above, anteriorly by the femur; in the middle, by the posterior surface of the knee-joint; and below, by the popliteus muscle. Posteriorly, it is bounded by the popliteal vein, which is rather external to it, and by the sciatic nerve, which is still more superficial and external to it; above, by the semi-membranosus muscle; and below, by the heads of the gastrocnemii. It is here also crossed by the posterior tibial nerve. It has to its outer side, the biceps, external head of the gastrocnemius, and origin of the plantaris muscle: the gastrocnemius forms its internal boundary. In this course, the popliteal artery sends off numerous small muscular branches above, to supply the muscles in the lower and back part of the thigh; and to anastomose with the perforating ramuli of the ramus profundus. These vessels have, however, no distinct names. Besides the above, the popliteal artery gives off five rami, which are more important, and supply the knee-joint; and then ultimately terminate, by sending off inferior muscular branches.

(A.) *Ramus articularis superior internus.*—The precise point at which this ramus is separated from the popliteal, is very various, and may occur at any part of the distance from where it penetrates the adductor magnus, to the internal condyle. It reaches its course inwards, behind the vastus externus and adductor muscles, close upon the bone; passing forwards, above the internal condyle of the femur; and anastomoses with the ramus anastomoticus magnus, and the ramus articularis externus. It also sends some ramuli downwards, in the direction of the tendon of the adductor magnus, to anastomose upon the inner side of the knee-joint with the inferior articular ramus.

(B.) *Ramus articularis superior externus*—arises from the outer side of the popliteal artery, and proceeds immediately outwards, close to the bone, behind the tendon of the biceps, winding around the femur above the external condyle; and having gained the fore part of the femur, it divides into two ramuli. The superior, or deep-seated, takes its course upwards, to supply the periosteum and muscles on the fore part of the thigh, and anastomoses with the muscular rami of the femoral artery. The superficial and anterior ramulus passes forwards, above the external condyle of the femur, through the vastus externus muscle, to gain the patella, upon which it anastomoses with the internal superior articular ramus.

(C.) *Ramus articularius medius, vel azygos*—is much smaller than the two preceding rami, and passes forwards through the posterior ligament of Winslow, to gain the interior of the knee-joint, where it divides into two ramuli; one of which remains external to the synovial membrane, and supplies the adeps and cellular membrane at the back part of the joint; the other distributes itself to the synovial membrane, the crucial ligaments, and the interior parts of the joint.

(D.) *Ramus articularis inferior internus*—arises from the outer side of the popliteal artery, immediately above the popliteus muscle, and takes its course inwards in front of the posterior tibial nerve and gastrocnemius externus muscle, between them and the head of the tibia, around which it runs, behind the internal lateral ligament of the knee-joint, and the tendons of the sartorius, gracilis, and semi-tendinosus muscles; having reached the fore part of the tibia, it runs up the inner edge of the ligamentum patellæ, to gain the bone; and upon it anastomoses with the superior inner articular, and inferior external articular rami.

(E). *Ramus articularis inferior externus*—arises from the outer side of the popliteal artery, below the knee-joint, but above the head of the fibula. It takes its course outwards, along the convexity of the external semilunar cartilage; covered, in its course, by the gastrocnemius externus, plantaris, external ligament of the knee-joint, and tendon of the biceps; then having gained the fore part of the tibia, it runs along the outer edge of the ligamentum patellæ to gain the bone, where it anastomoses with the last-described ramus. In this course, it also supplies ramuli to the muscles, and anastomoses with the superior, external, and middle articular rami.

The inferior muscular branches supply the gastrocnemii and solei, and anastomose with the posterior and anterior tibial rami—these are sometimes called the surales.

The popliteal artery, after having given off the preceding vessels, continues downwards, behind and to the lower edge of the popliteus muscle, where it divides into the posterior and anterior tibial rami.

(F.) *Ramus tibialis posticus*—is the larger of the two terminating branches of the popliteal artery, from which it separates at the superior extremity of the soleus muscle; anterior to which, it passes downwards upon the posterior surface of the flexor longus digitorum, and tibialis posticus muscles, to the malleolus internus; passing behind which, it gains the sole of the foot; and immediately upon the inner side of the abductor pollicis, it divides into its two terminating plantar ramuli.

In its course downwards upon the leg, it passes in an oblique direction, from above to below and from without to within;—in the upper and middle third of the leg, being covered by the gastrocnemius, and soleus muscles; but in the lower third, it is only covered by the skin, superficial and deep fascia. When first given off from the popliteal artery, it lies upon the tibialis posticus, then upon the flexor longus digitorum; and below, upon the tibia, and internal lateral ligament of the ankle-joint; separated, however, from the superficial layer of muscles, by the deep fascia of the leg. In the above course, it sends off only one ramulus of importance; but it supplies small ramuli to the popliteus, soleus, and gastrocnemii muscles; and an inch below the popliteus muscle, gives off—

(*a.*) *Ramulus peronæus*—which is variable in its size, sometimes being equal to the posterior tibial in its dimensions, at others being very small, or even entirely wanting. It directs itself obliquely downwards and outwards, along the inner edge of the fibula, nearly to the malleolus externus, where it forms two terminating ramusculi; above, it is covered by the soleus, separated from it, however, by the deep fascia of the leg; below, by the flexor longus pollicis: at first it rests upon the tibialis posticus, through the fibres of which it passes, and then lies on the interosseous ligament. In this course, it furnishes small posterior ramusculi to the muscles of the calf of the leg, and anterior ones to the deep layer of muscles; after which it divides into—

(α.) *Ramusculus peronæus posterior.*—This appears to be a continuation of the peroneal ramulus, and passes downwards behind the malleolus externus, distributing ramifications to the muscles in its course: when it has gained the posterior part of the ankle-joint, it sends a posterior malleolar ramification to anastomose with the posterior tibial ramulus, and to supply the adeps and cellular membrane between the tendo Achillis and posterior part of the ankle-joint.

The ramusculus peronæus posterior, still continues behind the malleolus externus, and reaches the outer side of the foot, where it anastomoses with the external plantar ramulus; and in front of the tarsus, with ramuli from the tibialis anticus.

(β.) *Ramusculus peronæus anterior*—perforates the interosseous ligament, to gain the fore part of the leg, passes under the peronæus tertius muscle, descends in front of the inferior tibio-fibular articulation, and passes to anastomose with the ramus tibialis anticus; and together, supply the anterior malleolar ramification, and the ligaments of the tarsus. This ramusculus is, in some cases, very large, and seems destined to perform the office of the anterior tibial ramus, which, in such instances, is proportionably small.

After the ramus tibialis posticus has given off the ramulus peronæus, in its passage down the back part of the leg, it gives off ramuli to the muscles, and a nutritious one to the tibia, which passes into the bone through a foramen which is directed from above downwards, and is situated about the centre of the bone. When the posterior tibial ramus has reached the inner side of the malleolus internus, it sends off small ramuli to supply the periosteum of the bone, and muscles proper to the great toe; and usually between the origins of the abductor pollicis pedis, it divides into its two terminating plantar ramuli.

(*b.*) *Ramulus plantaris internus*—is smaller than the external terminating ramulus, and passes forwards along the inner edge of the foot, upon the upper surface of the abductor pollicis muscle, and extends as far as the base of the first phalanx of the great toe. In this course, it sends off ramusculi to supply the ankle-joint, the muscles of the great toe, and the flexor brevis digitorum; also ramusculi which wind around the inner side of the foot upon the tarsus and metatarsus, to anastomose with the ramus tibialis anticus, and terminate by supplying the great toe.

(*c.*) *Ramulus plantaris externus*—seems like a continuation of the posterior tibial ramus. It immediately separates itself from the internal ramulus, and directs itself outwards and forwards; first resting upon the upper surface of the abductor pollicis, then upon the flexor brevis digitorum communis, being between it and the musculus accessorius; it still continues outwards to the metatarsal bone of the fifth toe, from the base of which it runs between the flexor digitorum brevis, and abductor minimi digiti, where it is straight in its course, and superficially placed; it then changes its direction, passes inwards inferior to the tendons of the flexor longus digitorum and lumbricales, and is placed upon the under surface of the interossei muscles: having arrived in the interspace between the anterior extremities of the metatarsal bones of the first and second toes, it terminates by anastomosing with the deep communicating ramulus of the ramus tibialis anticus. In this course, the external plantar ramus forms the great plantar arch, the convexity of which looks forwards and outwards, and the concavity backwards and inwards. The ramulus plantaris externus, before it begins to form the plantar arch, sends off numerous ramusculi to supply the muscles of the sole of the foot, and to anastomose with the ramusculus peronæus posterior, and internal plantar ramulus. From the arch itself, ramusculi are also distributed: from the concavity the—

(α.) *Ramusculi perforantes*—which pass to the interossii muscles, and anastomose on the dorsum of the foot, with the anterior tibial ramus; and from the convexity the—

(β.) *Ramusculi digitales.*—The first of these arises from opposite the metatarsal bone of the little toe, passes forwards between it and the muscles proper to the toe, proceeds forwards to the extreme phalanx along its outer side, and then anastomoses at the tip of the toe, with the corresponding ramusculus from the opposite side.

The second digital ramusculus, takes a course between the metatarsal bones of the fourth and fifth toes; and having passed forwards to the cleft between the two, it receives a metatarsal ramusculus from the anterior tibial ramus, and immediately after it divides into two ramifications—one of which passes along the tibial side of the little toe, and the other along the fibular side of the fourth toe.

The third and fourth digital ramifications are distributed precisely in a similar manner; and like the digital ramifications on the fingers, are accompanied with corresponding filaments of nerves.

(G.) *Ramus tibialis anticus*—immediately after it is separated from the popliteal artery, is directed forwards, through the fibres of the tibialis posticus muscles and the upper hiatus of the interosseous ligament, when it is placed in the fore part of the leg, upon the anterior surface of the interosseous ligament, along which it proceeds downwards; and passing behind the ligamentum annulare, gains the dorsum of the foot, continues to the cleft between the metatarsal bones of the great toe, and the toe next to it, and terminates by anastomosing with the ramulus plantaris externus. A line drawn from the head of the fibula to the base of the metatarsal bone of the great toe, will be parallel to the course of this ramus in its whole extent.

In this course, before it passes through the interosseous hiatus, it is placed between the fibres of the tibialis posticus and the flexor longus digitorum muscles, to both of which it sends off ramuli. When it has reached the front part of the leg, in the four upper fifths of its extent, it rests upon the interosseous ligament, but in the lower fifth, upon the tibia. Anteriorly, above, it is covered by the tibialis anticus, and extensor communis digitorum; and below, by the extensor proprius pollicis; it is bounded upon its inner side, in its whole course, by the tibialis anticus and tibia; and on its outer side, above, by the extensor digitorum communis, and below, by the extensor proprius pollicis; being accompanied by a nerve, which does not however pass through the interosseous hiatus with it, but winds around the head of the fibula.

While upon the leg, it sends off three ramuli—

(*a.*) *Ramulus recurrens*—is separated from the ramus tibialis anticus, immediately it has perforated the interosseous hiatus; takes its course upwards and inwards, through the substance of the tibialis anticus muscle, and is distributed to the inner side, and fore part of the knee-joint, where it anastomoses with the inferior articular rami, from the popliteal artery.

The ramus tibialis anticus, in its course downwards to the ankle-joint, distributes numerous ramuli to the neighbouring muscles; but within one or two inches of the ankle-joint, it sends off—

(*b.*) *Ramulus malleolus internus*—which passes transversely inwards, between the tibialis anticus tendon and the tibia, to reach the malleolus internus, where it divides into numerous ramusculi to supply the ankle-joint, and to anastomose with the ramus tibialis posticus.

(*c.*) *Ramulus malleolus externus*—usually arises opposite the last-described, but sometimes lower down, and takes its course outwards upon the fibula, behind the tendons of the extensor communis digitorum, and peronæus tertius; in this part of its course anastomosing with the ramusculus peronæus anterior, and supplying the anterior ligament of the inferior tibio-fibular articulation. It still continues outwards, gains the malleolus externus, divides into numerous ramifications, which anastomose posteriorly with the ramusculus peronæus posterior, and inferiorly are lost upon the dorsum of the foot—anastomosing with the ramulus plantaris externus. The ramus tibialis anticus now proceeds over the tarsus, on the fibular side of the tendon of the extensor proprius pollicis; and having gained the dorsum of the foot, proceeds forwards to its termination.

In front of the ankle-joint, and while crossing the os naviculare, this ramus gives off—

(*d.*) *Ramulus tarsalis.*—This takes its course outwards, under the tendons of the extensor brevis digitorum communis, and the tendon of the peronæus brevis; and terminates by supplying the muscles proper to the little toe, and by anastomosing with the external plantar ramulus. The ramus tibialis anticus, having reached the metatarsus, sends off—

(*e.*) *Ramulus metatarsalis.*—It takes its course outwards, over the heads of the metatarsal bones supplying their articulations; anteriorly sending off three or four long ramusculi in the three outer interosseous spaces, and which terminate by communicating with the digital ramusculi of the external plantar ramulus.

When the anterior tibial ramus gains the anterior part of the interspace between the first and second metatarsal bones, it terminates by dividing into two ramuli.

(*f.*) *Ramulus communicans*—which dips down at once into the sole of the foot, and anastomoses with the termination of the ramulus plantaris externus.

(*g.*) *Ramulus pollicis*—follows the interval of the two first metatarsal bones, and divides into two ramusculi to supply the opposite sides of the first and second toes. Before the ramus tibialis anticus divides into its two described terminating branches, it sends some ramusculi of inferior importance along the dorsal surface of the great toe.

LECTURE XXVII.

Practical Remarks.

Having finished the descriptive anatomy of the arteries, our next consideration is the practical utility which a thorough knowledge of these vessels imparts to the accomplished surgeon. No man ought to practice surgery, who has not made the study of the arteries a principal object of his professional knowledge.

In order to impress the great importance of this branch of anatomical science, I have reserved the practical remarks, connected with the arteries, for a separate lecture; that, in a connected view, I may perform and explain the several operations which are employed in tying the various arteries of the body.

Such operations are generally required to stop the hæmorrhages which may occur in accidents or from diseases; and in the latter most frequently, in order to stop the flow of blood to an aneurismal tumour. I will, therefore, very briefly enumerate some of the diseases incident to the arteries; and in so doing, lead your attention to the causes which frequently lead to the formation of aneurisms.

The arteries, in common with most animal structures, are liable to inflammation and its consequences; such as the effusion of lymph, adhesion, suppuration, and gangrene.

The peculiar organization of the arteries, and their particular function circulation, occasions certain modifications of disease, which are only to be met with in the arteries themselves; of which the disease named aneurism is an example.

There is a great tendency in arteries to the adhesive inflammation, whether excited from accident or other causes. It is to this tendency that we owe the process of reparation from wounds or disease; the lymph thrown out becoming the matrix of the new organized structures.

Even upon mere pressure, lymph will be thrown out in the interior of a vessel; and if long continued, as in the case of tumours of slow growth, such depositions will occasion the final obliteration of the vessel. Similar effusions of lymph sometimes take place near to an ulcerated part; and forming plugs, thus become the means of final obliteration.

Effusions are met with in various situations, but particularly in the large arterial trunks, and in the heart itself, of which there are several very fine specimens in our Museum. These effusions becoming detached, in some instances, appear to occasion the obliteration of an artery, by forming a plug at the first place at which its progress becomes impeded. In the Museum we have specimens of the aorta thus obliterated by a firm, fibrous coagulum, which is continued into the iliacs.

In acute inflammation of the arteries, the internal and middle coats exhibit a high degree of color, with the thickening and effusion of lymph: this must not, however, be mistaken for a florid red appearance that occasionally occurs, in which the internal coat only has a deep scarlet color. Sometimes this appearance will be general; at others, only in patches: it is also unattended either by effusion of lymph, or thickening of its coats. Such appearances have been supposed to characterize peculiar idiopathic febrile action.

The arteries are liable to chronic inflammation: to which state I more particularly wish to draw your attention, as a precursor of aneurismal tumours.

It has been observed, that persons who have taken large quantities of mercury, are particularly liable to chronic inflammation of the arteries; in which the internal coat becomes thick, soft, and of a deep red color. Similar appearances are also seen in the neighbourhood of calcareous deposits: sometimes in patches; at others, more generally diffused. From these and other causes, the vessels undergo a morbid change, in which they are less capable of sustaining the force of the current of circulation, and they give way; sometimes rupturing to such an extent as to cause instant death; at others, an ulcerative process is set up, in which the coats of the vessel will be partially or completely destroyed, so as to admit of the escape of the blood into the surrounding cellular membrane, and thus forming an aneurism.

Ulcerations of the above description are not unfrequently met with, encircling chalky depositions in the coats; and when these are pressed, matter will escape from beneath them. The appearance of puss within the interior of an artery, in *post mortem* examinations, is, however, rare, from its having been removed by the current of the circulation.

Sphacelus in arteries seldom or ever occurs, unless in connection with the mortification of the parts which surround them. In such instances, fatal hæmorrhage is prevented by the following process, which may be regarded as one of the most wonderful provisions of nature:—The blood coagulates to a considerable extent above the line of sphacelation, at first forming only an effectual plug; this afterwards becomes absorbed, and the vessel completely closed.

Besides the above diseases, the coats of the arteries are separately liable to various peculiar morbid changes.

The internal lining or membranous coat sometimes becomes thickened, and converted into a substance resembling cartilage. There is in the Museum fine specimens of this disease, accompanied with calcareous and atheromatous depositions, in the lower part of the aorta and the iliacs. Such alterations of structure will often be found to be surrounded with chronic inflammation; the redness of which, however, does not extend to the cartilaginous structure. This state is a frequent occurrence about the valves, and in diseases of the heart itself; occasioning that increased action of the left ventricle, which has been named active aneurism of the heart.

The internal coat of the arteries is also liable to become thickened, exhibiting a pulpy structure, somewhat resembling minute granulations; occasionally regularly disposed; at other, irregularly, and assuming a fleshy appearance. This leads to a weakened state of the internal coat, from which it will readily be lacerated, aud thus lay the foundation of aneurism.

A frequent disease is met with in the cellular membrane, which connects the internal with the middle coat. In this, an atheromatous or purulent matter, of an opaque yellow color, fills the cells between the coats, and causes a slight elevation. When punctured, purulent or cheesey matter may be pressed out; and when very abundant, occasionally leads to the obliteration of an artery.

One of the most frequent alterations of structure is the deposition of calcareous matter, perhaps erroneously termed ossification of the arteries. In old persons, this is very commonly met with: sometimes enclosing nearly the whole circle of the artery; at others, in very irregular patches; of which we have several fine specimens in the Museum. These depositions are less frequent in the upper than in the lower extremities: they are frequent in the aorta, and rare in the pulmonary artery. Sometimes these depositions are surrounded by ulcerations; which, penetrating the internal coat, will give rise to the formation of aneurism; or, by weakening the parietes, it may occasion a rupture of an artery, when spurious aneurism will immediately follow.

It will be obvious, that a due consideration of the various pre-existing symptoms should be carefully attended to, as they form a guide to the proper mode of constitutional treatment.

In examining the relative position of the aorta with the neighbouring important organs, it must appear obvious at once how various must be the symptoms produced by any enlargement of this large arterial trunk, from its consequent pressure upon them. Thus an aneurism may produce dyspnœa, by pressing on the trachea, or by preventing the free access of blood to the lungs through the pulmonary artery: difficulty of swallowing may occur, from its pressure on the œsophagus;—a livid countenance and œdematous upper extremities may be prominent symptoms, from the pressure preventing a free return of blood through the venæ innominatæ. Sudden and immediate death is usually the sequel of these symptoms, from the aneurism bursting either into the trachea, œsophagus, or chest—as indicated by coughing up or vomiting large quantities of blood. In the museum at Guy's Hospital we have several preparations exhibiting the diseased states of the vessels which had occasioned such fatal terminations.

The aorta is sometimes obliterated during life, by the deposition of bone, or the formation of firm coagula, of which there are three specimens in the museum of Guy's Hospital. There is also a preparation, particularly worthy attention, in which there are minute openings in an aneurismal sac of the lower part of the arch of the aorta, produced by two spiculæ of bony matter in a bronchial gland—the rest of the artery was sound. The patient died suddenly, from the escape of blood into the posterior mediastinum.

If, then, the student dwells upon the consideration of the effects produced by these circumstances, he will see the necessity for mature thought before he proceeds to the mechanical means of alleviating some of the symptoms. I may exemplify what I mean, by relating a case, in which Mr. Key was called upon to perform the operation of bronchotomy, for a supposed disease of the larynx; but, by a judicious investigation into the history of the case, he discovered that the symptoms arose from an aneurism of the aorta pressing on the trachea: and thus he saved the patient from a distressing operation. There is a preparation in the museum at Guy's Hospital, in which the larynx was opened for difficulty of breathing, caused by an aneurism pressing on the trachea below. In difficulty of swallowing, also, stricture of the œsophagus is not always to be supposed the only cause, as it may arise from the pressure of an aneurismal tumour.

Having considered the diseases of the arteries, which lead to the formation of aneurismal tumour, as well as the complicated symptoms induced by them, we will now proceed to consider the surgical operations necessary for their cure; which consists of the application of a ligature around the diseased vessel, so as to preclude the possibility of the flow of blood to the tumour; which effect is permanently produced, not by the mere approximation of the sides of the vessel, and their adhesion, but by its rupturing the internal coat, and thus inducing an effusion of adhesive matter, which obliterates the vessel. It however sometimes occurs, that the aneurismal tumour is situated so near to the heart, that it does not admit of the application of a ligature around the vessel, between the heart and the tumour: in such instances, it will sometimes be proper to place a ligature on the distal side of the tumour, in order to induce an inflammation, which may extend into the cavity of the aneurismal sac, and thus effect its permanent obliteration.

There are several cases on record, where this mode of operating has succeeded.

Previous to a particular description of the several modes of tying the different arteries, it will be necessary to inform the student, that he is not to expect invariably to find the arteries as we have here described them; but that, in each operation, difficulties may arise from peculiarities of distribution. These deviations from the general mode of distribution, have already been mentioned in the descriptive anatomy; but we shall again refer to them, in the history of each operation, as their importance cannot be too much impressed upon the memory.

In the Museum we have several excellent preparations of the varieties of distribution, which so frequently occur in the large arteries arising from the arch of the aorta; and one in which the aorta arises from both ventricles of the heart. In this specimen, there is a communication in the upper part of the septum of the ventricles; and the pulmonary artery communicates with the aorta by the ductus arteriosus, but does not open into the right ventricle.

The two common carotids, not unfrequently have been found to arise by one common trunk; after which, they are divided to be distributed in the usual manner; in such instances, the right subclavian, arises from the anterior part of the arch.

Four arteries sometimes arise from the arch of the aorta—the additional one being usually placed between the left carotid and left subclavian; from whence it passes in the usual course of the left vertebral ramus, through the transverse processes of ths cervical vertebræ. In other instances, the fourth vessel will be distributed to the thyroid gland; but when this happens, it is usually given off from the aorta, immediately to the left of the arteria innominata.

The right subclavian artery, is not very unfrequently given off from the left of the arch, either in common with the left subclavian, or separately; and then passing across the spine, either behind the œsophagus and trachea, or between them, to gain the right side of the neck. Of each of these varieties we have specimens in the Museum; and, indeed, such deviations are not so rare as might be supposed; for there is scarcely a season but some of them are to be met with in the dissecting room.

The large arteries arising from the arch of the aorta, are occasionally the subjects of aneurism, at such a distance from the heart as will admit of the application of a ligature.

The operation for placing a ligature around the arteria innominata, was first performed in 1818, by Dr. Mott, at New York; which operation we will now proceed to describe.

The patient being placed on his back upon a table of convenient height, an incision is to be made, three inches in length, in a direction upwards and backwards, commencing from the centre of the upper piece of the sternum, and then continued along the inner edge of the sterno-cleido mastoideus, so as to expose that muscle. The attachment of the sterno-cleido mastoideus to the sternum, should then be cautiously cut through; and the patient's head being raised from the pillow by an assistant, the operator should now separate the sterno-hyoideus and sterno-thyroideus muscles from the trachea with his fore finger, along which a probe-pointed bistoury is to be guided to divide them from their attachments to the sternum and posterior ligament of the sterno-clavicular articulation. In this step of the operation, some small vessels will be divided, and produce a hæmorrhage; but scarcely ever sufficient to render it necessary to secure them. The fore finger of the left hand may now be passed forwards into the chest, and just behind the middle part of the first bone of the sternum, the arteria innominata will be felt, lying upon the fore part and right side of the trachea; from which it may readily be separated, and a ligature be passed around it about half an inch below its bifurcation.

It has been recommended by some surgeons, that the operation for tying the arteria innominata, should be performed by making an incision from the centre of the upper piece of the sternum, upwards to the cricoid cartilage, in the mesian line of the trachea; then separating the sterno-hyoidei and sterno-thyroidei of one side from those of the other, the finger is to be passed down into the chest to secure the artery, as in the operation above described. But should more room be required, the sterno-cleido mastoideus, hyoideus, and thyroideus of the left side, should be divided in preference to those of the right; in consequence of the anterior position of the arteria innominata rendering the dissection on the right side more dangerous. In the dead subject, I have found this an easier mode of reaching the arteria innominata, than in that which I have first described.

The case in which Dr. Mott tied this vessel, did not succeed, as the patient died from hæmorrhage twenty-six days afterwards; from his having been improperly allowed to walk about too soon after the operation.

The *common carotid arteries*—may be secured, either above, or below the omo hyoideus muscle; and referring to the descriptive anatomy of this vessel, it will be obvious that the upper operation is by far the easier of the two.

Circumstances, however, may arise, from peculiarities in the situation of aneurismal tumours, or from the direction of lacerated wounds, which may preclude the surgeon from making a choice of the easier operation.

In performing the upper operation, as it is termed, the patient should be placed upon a long table, in a completely recumbent posture, the head being extended so as to stretch the neck. An incision is to be made, commencing just below the angle of the lower jaw, and extending three inches in a direction towards the side of the cricoid cartilage; dividing the common integuments, and the platysma myoides only. The fascia of the neck is next to be divided, cautiously, to the same extent—taking care to avoid numerous small veins, which are placed immediately beneath it; for which purpose a director is to be employed. The edges of the wound being separated, the carotid sheath will be exposed; and the operator should now look for the descending branch of the lingual nerve, which is usually placed rather to the outer side of the carotid sheath. This sheath should then be raised with a pair of forceps; and to be opened with care, the operator must hold the knife horizontally, and make gentle strokes upon the inner or laryngeal side, until the opening is of sufficient extent. This effected, the internal jugular vein will sometimes be seen, distending itself, so as to cover the artery at intervals. This vein must therefore be drawn with a blunt retractor towards the mastoid muscle; when the par vagum will be seen, between the artery and vein.

The aneurismal needle armed with a ligature is now to be introduced, from without to within, between the par vagum and the artery; at the same time taking care not to include the sympathetic nerve, or its superficial cardiac branch, which is placed on the tracheal side of the artery, but both of them outside the sheath.

The ligature is then to be tied, and one end of it cut off close to the vessel, while the other is to be secured on the side of the neck with a piece of adhesive plaster. This method is necessary, to prevent the possibility of its being entangled with any thing, or being drawn from the artery by any movement of the patient's head. The wound should now be dressed, and the patient placed in bed, with the head so raised as to relax the muscles of the neck.

For the performance of the lower operation, the patient should be placed in the recumbent posture, as before described; but the head should be rather more raised, so as to relax the sterno-cleido mastoideus, and the muscles which cover the carotid artery at the inferior part of the neck. The first incision should divide the common integuments, the platysma myoides, and superficial fascia; and should commence opposite to the cricoid cartilage, and extend downwards and obliquely inwards, along the tracheal edge of the sterno-cleido mastoideus, to within half an inch of the sternum. This incision exposes the inner edge of the sterno-cleido mastoideus, which forms the outer, and the sterno thyroideus, the inner boundary of the wound. These two muscles must then be separated from each other with retractors, including with the sterno mastoid muscle, a large vein usually found running along its edge. By this step the sheath of the carotid artery will be exposed, and the descending branch of the lingual nerve passing on its inner side. This nerve must then be drawn aside with the sterno thyroideus muscle. The omo hyoideus will be seen crossing the carotid sheath at the upper part of the wound; immediately below which muscle, the sheath should be opened, in the same cautious manner as described in the high operation; indeed, even more care is necessary, as the jugular vein is not only larger, but is influenced by the action of the heart; especially upon the left side, where the operation is one of greater difficulty than on the right, in consequence of the proximity of the œsophagus and the thoracic duct.

The operation for tying the *external carotid artery*, is similar to the upper operation for securing the common carotid; but should not be resorted to, excepting in such cases, where from accidents, or the removal of tumours in its neighbourhood, it may be immediately necessary to secure this vessel. In diseases, it is preferable to secure the common carotid, in consequence of the numerous ramuli of the external carotid being so likely to prevent its obliteration after the separation of the ligature.

Although it is not from this reason advisable to put a ligature around the external carotid artery itself, its branches may, either from disease or accident, require that operation.

Ramulus thyroideus superior—the first branch sent off from the external carotid, has frequently to be tied, from being divided in attempts at suicide; and I have myself twice seen a ligature placed around this vessel, in an attempt to cure bronchocele. When divided by an incised wound, the bleeding vessel is readily secured by taking it up with a tenaculum; or perhaps it is safer to take up both extremities, to secure them more effectually from the continuation of hæmorrhage, which is liable to occur, from the frequent anastomosis with its fellow, and with the inferior thyroideal ramulus. When a ligature is to be applied around this ramulus for a disease, the operation should be performed in the following way.

The patient should be placed on a table, in the same position as for tying the carotids, although the sitting position is frequently recommended; it is, however, a plan I deprecate, in all important operations; for when in the recumbent position, you deprive the patient of every fixed point for muscular action, and he remains passive, and more perfectly under your control. An incision should be made from the cornu of the os hyoides, obliquely downwards and outwards, to the sterno-cleido mastoideus, dividing the common integuments, platysma myoides, and fascia ; then with the handle of the knife clearing away the cellular membrane, and a plexus of veins immediately below the os hyoides, the superior thyroideal ramulus may be exposed. Care must be taken not to include the laryngeal nerve within the ligature when passed around the vessel, as this nerve accompanies the artery, but is rather deeper than it.

The *ramulus maxillaris, vel facialis externus*—and its numerous ramifications, offer various important pathological considerations in operations for the removal of glandular tumours from under the jaw, when it, or its submental branch is necessarily wounded; and from the depth of the parts, is secured with considerable difficulty.

The extirpation of the submaxillary gland, could not be performed without the division of the facial artery ; but this operation, is on other accounts rendered exceedingly difficult, from the depth to which this gland penetrates to gain the upper surface of the mylo hyoideus muscle, and become connected with the sublingual gland. These impediments render a perfect extirpation nearly impracticable.

In the removal of portions of the lower jaw, this artery must also be divided; but the difficulties accruing from its division may here be obviated, by taking care to divide it near to the alveolar process of the jaw, and not close to its inferior edge, under which it would retract so deeply as to render it extremely difficult to be secured. By placing the finger within the mouth, and pushing the parts forward from below the jaw, the divided extremity of the facial artery may be readily brought to view; and by this means, temporary pressure may be effected, both from within and without, in order to arrest any sudden or violent hæmorrhage. In operations on the lips for the removal of cancers, or the closing of hare lips, compression of the facial artery on the horizontal portion of the jaw, avails but little, in consequence of the free anastomosis of the coronary vessels, which must be themselves compressed.

After portions of the lips are removed, no ligature is required, as the suture which brings the parts together, may be so passed through the substance of the lip as to check all bleeding.

In the operation for fistula lachrymalis, attention should be paid to make the incision into the sac on its external side, in order to avoid wounding the arterial angular ramusculus.

The *ramulus lingualis*—in wounds and diseases of the tongue, may sometimes require to have a ligature placed around it; to effect this, an incision must be made from the upper edge of the cornu of the os hyoides, with a slight obliquity upwards and outwards, to the anterior edge of the sterno-cleido mastoideus; this incision should divide the skin and platysma myoides, so as to expose the cervical fascia, which should next be divided, to the same extent and in the same direction; thus laying bare the tendon of the digastric muscle, immediately below which is placed the lingual nerve, and still deeper the lingual artery, where it may be seen immediately above the cornu of the os hyoides, just as it is passing upon the upper surface of the stylo glossus muscle—some few fibres of which may require to be cut through, to enable the operator to place a ligature around it. In the living subject, this will be found to be a much more difficult operation than would be supposed, from the comparative facility of exposing the lingual artery in the dead subject.

Surgeons are sometimes required to divide the frenum linguæ, in cases called tongue-tied, shewing the child has not the free motions of the tongue. In this operation, a probe-pointed scissors should be used, and their blades directed downwards, and not towards the under surface of the tongue, in order to avoid wounding the ramusculus raninus.

The *occipital and posterior aural ramuli*—have, in some few instances, been tied, in cases of aneurism by anastomosis. The plan which may be adopted in securing these vessels, is to feel for their pulsation, and then to cut down immediately upon them.

The *ramulus temporalis*—is not unfrequently the subject of arteriotomy, in diseases of the eye or brain; and the following plan may be adopted for its safe performance.

The anterior ramusculus should be chosen; for if the ramulus be opened near the zygoma, and before its division, it is so covered by fascia, that it will be found difficult, afterwards to suppress the hæmorrhage. Having felt the anterior ramusculus with the fore finger of the left hand, the skin over it, is to be drawn downwards towards the face; then making an incision of an inch long, parallel to the ramusculus and below it, the tension of the finger being removed, the skin recovers its position, and brings the opening opposite the vessel,—which is immediately seen lying upon the aponeurosis of the temporal muscle. A probe is to be passed under the ramusculus, which may then be opened with a lancet; and when the quantity of blood required has been taken, the vessel is to be divided, and pressure applied to stop the hæmorrhage. The passing the probe under the vessel is not only useful to give a perfect command of it, but it prevents the wounding of the temporal aponeurosis.

Even with this precaution, spurious aneurism is sometimes the result of this operation; to cure which, the sac should be laid open, the coagulum turned out, and a ligature applied on each of the openings in the vessel.

The *subclavian artery*—is more frequently the subject of operation for the diseases which are incident to its axillary portion, than for diseases situated in its own course; this may, in some measure, be accounted for, from the axillary artery being exposed so much more to changes of position during the motions of the upper extremity.

To secure the *subclavian artery*, on the outer side of the scalenus anticus muscle, which is the situation invariably chosen for this operation, on account of the insuperable difficulties which are incident to its other portions, the patient should be placed in the recumbent posture upon a low table, with his shoulders slightly raised by a pillow being placed beneath them. The arm of the diseased side, is to be drawn downwards and held by an assistant close to the patient's body, the shoulder at the same time being pressed backwards. This places the subclavian artery in the best possible situation to be secured. The operator then draws the skin of the neck downwards upon the chest, rendering it tense over the clavicle. Supposing the clavicle is divided into four equal portions, an incision is to be made in the course of that bone to the extent of the two middle fourths—dividing the skin, superficial fascia, and platysma myoides. The inner boundary of the opening made by this incision, is formed by the outer edge of the sterno-cleido mastoideus muscle; the outer boundary, by the inner edge of the trapezius; above, by the receding skin; and below, by the clavicle. It occasionally happens, that the external jugular vein passes in such a direction as, without due caution, to endanger its being wounded by this incision; but it is usually underneath the sterno-cleido mastoideus muscle. The operator should now separate the deep fascia of the neck, and the cellular membrane, with the handle of his scalpel or a silver knife, until he reaches the acromial side of the scalenus anticus muscle; in doing which he is to avoid the large veins, which are passing to terminate in the subclavian. The particular object in this step of the operation, is to expose the outer edge of the scalenus anticus muscle, as it alone points out the precise situation of the subclavian artery, in its passage over the first rib. In effecting this object, some difficulty occasionally occurs, from the enlargement of the absorbent glands, which will render more dissection necessary. The third step consists in the operator passing his finger along the outer edge of the scalenus anticus muscle, until he reaches the first rib; upon which he will feel the subclavian artery pulsating under his finger; and with his nail as a director, he is then to separate the artery from its attachments to the first rib, so as to enable him to pass the aneurismal needle, armed with a ligature, under it—in a direction from within and below, upwards and backwards; taking care to avoid the axillary plexus of nerves, which are above and to the outer side of the artery. Before the ligature is tightened, the surgeon should ascertain by its pressure upon the artery, that with it, he commands the pulsation of the aneurismal tumour; for I have seen the ramulus supra scapularis so enlarged, as to be mistaken for the subclavian artery. The ligature being secured, one end is to be cut off close to the vessel; the other left, and the wound closed with adhesive plaster in the usual manner.

When the clavicle is much raised, either by the peculiar make of the individual, or from the pressure of the aneurismal tumour, the difficulty of the operation is much increased, and may lead to the necessity of dividing the omo hyoideus muscle, in order to obtain more space: but under all circumstances, the scalenus anticus muscle is the guide to the vessel. It is necessary to be very careful not to wound the external jugular vein, in the first step of the operation. The importance of this caution, I may instance by a case at Petersburg, related to me by Mr. Brodie, in which instantaneous death occurred from the division of this vein. Upon examination after death, the right auricle of the heart was found full of air; which can only be accounted for by the empty state of the vein at the moment of the division. Should any circumstance render the division of the vein necessary, two ligatures should be first applied.

The remaining portion of the arteries of the upper extremity, may be secured in any part of their course, excepting the middle third of the axillary artery, where it is surrounded by the axillary plexus of nerves, so as to preclude the possibility of applying a ligature in that situation.

It would be needless here to enter into a minute detail of the steps which may be required, in the several operations of tying those arteries; as the descriptive anatomy, it is presumed, must form an efficient guide. I shall therefore only mention, that in consequence of the frequent irregularities in the distribution of these vessels, any particular rules would lead to embarrassment upon the occurrence of such deviations; and that, therefore, it is of the utmost importance that the surgeon, before he proceeds to secure any of these vessels, should by the most careful examination, endeavour to ascertain whether such irregularities exist or not; by which he must accordingly regulate the steps of his operation.

There is, perhaps, no accident connected with the arterial system, more perplexing, than wounds in the palm of the hand; it seems to be, invariably, a bad practice to attempt to secure the vessel where divided; as in every fibre which you divide to expose the bleeding vessel, fresh injuries are accumulated, and the blood seems to issue from an extended surface, rather than from an individual trunk. The best mode of treatment is, therefore, first to press upon the radial or ulnar, or both vessels, as may be found necessary, to check the hæmorrhage; the patient should be kept in the recumbent position, and the hand enveloped in wet clothes: such a mode of treatment is to be continued as long as the surgeon may consider it necessary for the healing of the wounded vessel, when the pressure may be removed. But should the hæmorrhage return, the radial or ulnar, or both arteries, must be secured, at the lower third of the fore arm, to prevent fatal consequences.

The intermediate arteries between the upper and lower extremities, admit but of few surgical remarks, as far as refers to operations; but their relative position with important organs should be carefully studied, to enable us to form a just diagnosis from symptoms which are produced by the pressure of aneurismal tumours upon them.

I have already alluded to the various symptoms induced by the pressure of aneurismal tumours of the arch of the aorta, and its large arteries.

Aneurism of the descending aorta, may produce a large tumour in the back, which might possibly be mistaken for abscess; the ribs being absorbed from its pressure. It may also produce great difficulty of breathing, from pressure on the lungs; wasting of the body, from pressure on the thoracic duct; venous congestion, from retarding the flow of blood in the vena azygos; and, subsequently, difficulty of swallowing, by pressing on the œsophagus. Still, urgent as these symptoms are, it requires a scientific surgeon to discover their cause; but the truth may generally be elicited, by a close examination of the action of the heart, and arterial system; when it will be found, that all these symptoms are aggravated by any cause which hurries the circulation; and the patient expresses himself, as feeling as though there were something alive within him—followed by frequent tendency to fainting.

The abdominal aorta, when the subject of aneurism, not being so covered by bony parietes as its thoracic portion, offers a more ready opportunity for examination; but still, covered as it is by the organs of digestion, and the chylopoetic viscera, it produces such a variety of symptoms as to render the diagnosis difficult.

Pulsating tumours in the abdomen, must not be too hastily pronounced aneurismal; for enlarged mesenteric glands, or any tumour lying over the aorta, may receive so strong a pulsatory motion from it, as to lead to an erroneous opinion.

The mode of examining such a patient, is to place him on his back, and then pressing the tumour towards the aorta, the pulsation will be strongly felt, in proportion to the force employed, if it be aneurism; but, on the contrary, if a solid tumour, the same degree of pressure will stop the pulsation of the aorta itself. The patient may also be desired to turn upon his hands and knees; in which position, a solid tumour would gravitate from the aorta, and lose its pulsation; while, if it be aneurism, this change will make no alteration in the pulsatory motion. By close attention to these rules, I have had frequent opportunities of estimating their value, in forming a just diagnosis.

Persons who are the subjects of aneurism of the abdominal aorta, almost invariably complain of a sensation of fainting upon bending the thighs upon the trunk; as, for instance, in the attempt to mount a high horse, when the thigh is flexed to its greatest extent to place the foot in the stirrup.

In such diseases, the life of the patient may be prolonged by perfect rest; great attention to diet, which should never be of a stimulating quality; by due regulation of the action of the bowels; and by frequent abstraction of small quantities of blood. Indeed, even in this most formidable of diseases, there is yet a gleam of hope; for we have in our museum at Guy's Hospital two preparations, besides others which are extant, in which the aorta had become obliterated, and the circulation still preserved by collateral vessels to the lower extremities.

The existence of such preparations induced Sir Astley Cooper, who was the first surgeon that made the experiment, to resort to the application of a ligature around the abdominal aorta, about three quarters of an inch above its division, in a case of aneurism of the external iliac artery.

Sir Astley Cooper first attempted to apply a ligature upon the common iliac, but from the size of the tumour he found it impracticable; and therefore proceeded to the aorta itself. This he effected in the following manner:—An incision was made in the course of the linea alba, three inches long, in the centre of which was the umbilicus, which was avoided by a curve to the left. The cavity of the abdomen being opened, the convolution of the intestines were turned aside, so that the aorta might be felt pulsating through the mesentery, which was next lacerated by the finger nail, and a ligature readily applied around the aorta; care being taken not to include any of the filaments of the aortic plexus of nerves.—The patient survived the operation forty hours: and on a *post mortem* examination, there was no reason to suppose the patient had fallen a victim to the operation itself, but to the previous hæmorrhages, and constitutional irritation induced by the disease.

Mr. James, of Exeter, had the courage to follow the example of Sir Astley Cooper, in a case of equal urgency; and performed the operation in a similar manner; his patient, however, died in a few hours afterwards, complaining, from the moment the ligature was applied, of great pain in the diseased limb.

Although both of these cases proved unsuccessful, it does not follow that the operation is to be abandoned; nor, on the other hand, because preparations may be seen, in which the aorta has been obliterated by disease, and that the circulation has yet been carried on collaterally, is it to be considered that the application of a ligature is necessarily to lead to the same happy result: for it is to be remembered, that when disease obliterates the aorta, it is rendered impervious by degrees, and that the collateral branches simultaneously and proportionably enlarge; while, on the contrary, by the application of the ligature, the effects are immediate, without a reciprocal accommodation to so great a change.

We shall now proceed to the consideration of the application of ligatures upon the arteries of the lower extremities.

The common iliac, and the two branches into which it divides, and indeed even the aorta itself, I believe may all be tied, with most facility to the operator and safety to the patient, by the following operation; the only difference being in the extent of the wound. The patient being placed in an horizontal position, an incision, commencing half an inch on the pubic side of the centre of Poupart's ligament, and a little above it, is to pass upwards in the direction of an imaginary point, midway between the umbilicus and ensiform cartilage, for three inches in extent. This incision is usually recommended to be made from Poupart's ligament in a direction to the umbilicus; but it will be found, that the above mode is more in the course of the iliac arteries, and there is less liability to wound the epigastric. This first incision divides the skin and superficial fascia of the abdomen, and exposes the aponeurosis of the external oblique muscle, which is next to be cut through in the same direction; and the finger is to be introduced underneath the free edges of the internal oblique and transversalis muscles, which are now cautiously to be divided with a probe-pointed bistoury, in the direction of the external wound. This step exposes the fascia transversalis, and the spermatic cord lying upon it; the operator is to trace the spermatic cord to the internal ring, tear through the fascia spermatica interna, draw the cord upwards and inwards, and pass his finger into the abdomen, through the internal ring, and insinuate it under the peritoneum, when he will immediately feel the external iliac artery; he is then to separate it from its accompanying vein, which lies on its inner side, and to pass the point of the aneurismal needle between the two vessels, directing it outwards to enclose the artery; the ligature is to be tied as soon as it is ascertained that it will command the pulsation of the artery, and the edges of the wound closed by strips of adhesive plaster.

If the object be to secure the internal iliac artery, the incision is to be continued an inch higher than in the last-described operation. The peritoneum is to be detached by the finger, in a direction outwards from the iliac fossa, inwards towards the pelvis, when the external iliac artery is to be traced backwards to the sacro-iliac symphysis; where in the centre of an imaginary line drawn from the umbilicus to the anterior and superior spinous processes of the ilium, the origin of the internal iliac may be felt, posterior, and to the inner side of the external iliac artery. The internal iliac is then to be separated from its accompanying vein, which is behind it; and a ligature is to be conveyed around the vessel, directing the needle from within to without—taking care not to include the ureter, which crosses the internal iliac at this point; and which may always be avoided, by feeling for the ureter's obeying the motions of the peritoneum, which the blood-vessels do not.

The common iliacs, and even the aorta itself, may be secured by this latter operation.

Sir Astley Cooper prefers a different operation for tying the external iliac artery, and recommends a semilunar incision to be made, extending from an inch to the inner side of the abdominal ring, to an inch of the spine of the ilium, the convexity of which looks downwards and outwards; by this incision, the aponeurosis of the external oblique muscle is exposed, and is to be divided in the same direction as the external incision—thus laying open the inguinal canal. The free edges of the internal oblique and transversalis muscles, are to be drawn upwards; and when they arise from more than the outer half of Poupart's ligament, they will require to be separated from it to expose the internal ring. The fascia spermatica interna is next to be torn through, the spermatic cord to be drawn upwards, and the artery may immediately be felt and secured. This operation, which I have four times performed, offers greater facility in securing the vessel, than the mode before described; but it is attended with this disadvantage, that if upon exposing the artery disease should exist, so as to render it necessary to secure it higher up, a further operation is required; and also by this mode, the ligature is liable to be too near to the epigastric and ramus circumflexus ilii.

We possess in our museum at Guy's Hospital, a preparation made from a man in whom the external iliac artery had been tied, twenty years before, by Sir Astley Cooper; it presents a beautiful view of the manner in which the circulation had been carried on by collateral anastomosing branches. The principal enlarged vessel, is the obturator; but the ischiadic, gluteal, and circumflex ilii, contribute to the new current of circulation.

Some surgeons have laid down rules for securing the gluteal, ischiadic, and internal pudic rami; but in diseases of these vessels, it is better to apply a ligature around the internal artery, than to attempt to tie either of them, as they are so deeply seated, and covered by such a mass of muscles.

The femoral artery is frequently the subject of operation, in consequence of aneurism of the popliteal; which, although so much shorter than the femoral, is yet subject to such extensive changes of position, from the motions of the knee-joint, that it is much more liable to disease. The femoral artery may be tied in any part of its course; but the situation which surgeons most frequently choose for the application of the ligature, is at the junction of the superior with the middle third of the thigh. The patient should be placed in the horizontal posture, and the leg of the diseased side should be flexed, and made to cross below the knee of the healthy one. The surgeon is then to commence his incision two inches below Poupart's ligament, at a point which would terminate a perpendicular line, drawn from midway between the anterior superior spinous process of the ilium, and symphysis pubis. The incision is to be continued obliquely downwards and inwards, for three inches in length, along the inner edge of the sartorius, dividing the skin and fascia lata, so as to expose the sartorius muscle. In this step if the surgeon, as sometimes happens, from the enlarged state of the limb, or from the great accumulation of fat, has made his incision too much on the inner side of the thigh, he will expose the adductor longus, instead of the sartorius muscle; this circumstance he will immediately discover, by observing the direction of the muscular fibres,—which in the adductor longus, pass from within to without, but in the sartorius, from without to within. This may be rectified without a further incision, by rotating the limb outwards, and widely opening the outer edge of the wound. The sartorius muscle is then to be raised with the handle of a scalpel, when the femoral sheath is immediately exposed, and should be opened with great caution. The femoral artery will be found lying above its vein, and generally having a branch of the saphenus nerve running upon it. With a director, or a silver probe, the operator should now separate the artery from its vein and nerve; but not to a greater extent than is necessary to enable him to pass the aneurismal needle, armed with a ligature, around it. Having ascertained that the ligature commands the artery, it is to be secured, and the wound closed in the usual manner.

This is termed the upper operation on the femoral artery, in contradistinction to the lower operation; which is performed at the junction of the middle, with the lower third of the thigh.

In the lower operation, the patient is to be placed in the same position as in the upper, excepting that the knee should be rather more rotated outwards. An incision is then to be made, commencing about the centre of the thigh, and to be continued perpendicularly downwards, three inches in length, cutting through the skin and fascia lata; in which step, the surgeon must take care not to wound the saphena major vein. By this incision the sartorius muscle is exposed, and must be raised, and drawn inwards, instead of outwards as in the upper operation, to bring into view the tendons of the adductor magnus muscle, and the sheath of the femoral artery, composed of a fascia common to the adductor magnus and vastus internus muscles. This sheath is now to be laid open, when the artery will be immediately exposed, with its vein behind it, but no longer accompanied by the branch of the saphenus nerve. A ligature is now to be passed around the artery, taking care not to apply it too near to the ramus anastomoticus magnus, which would interfere with the usual effects of the application of the ligature.

The popliteal artery may be tied, by following nearly the same steps as described in the last operation; the only difference being, that the incision is to be continued rather lower down, so as to expose the sheath posterior instead of anterior to the tendon of the adductor magnus, which leads immediately into the upper part of the popliteal space.

In such operations, the surgeon should examine whether or not there be varieties from the usual distribution of these vessels, in order that he may take such other steps as may be consequently required.

From injuries to the arteries in the sole of the foot, as well as in the leg to the posterior tibial, it is sometimes necessary to secure this vessel. In the lower third of the leg, between the tendo Achillis and malleolus internus, the posterior tibial ramus may be exposed by making an incision, two inches and a half in extent, along the inner edge of the tendo Achillis. This is to cut through both the superficial and deep fascia of the leg, when the vessel will be exposed, accompanied by its two veins, and its nerve, which is behind and to its outer side. The vessel is then to be secured. The posterior tibial ramus, may, however, require to be tied in the calf of the leg; which is a more difficult operation, and is to be performed in the following manner:—The patient is to lie in the horizontal posture, on his side, so as to rest on the outer side of the injured or diseased limb. The surgeon is then to feel for the inner spine of the tibia; and rather anterior to it, is to make an incision three inches long, through the skin, superficial fascia, and the origin of the soleus muscle; he is then to separate the origin of the soleus from the tibia, in the whole extent of this wound; by which means he will expose the inner spine of the tibia, and the deep fascia of the leg, which arises from it. This fascia is now to be divided to the same extent, when the artery may be felt lying upon the deep muscles, about an inch to the outer side of the tibia. It is then to be separated from its venæ comites, and an aneurismal needle passed around it; taking care not to include the posterior tibial nerve, which in this situation may either be just crossing it, or on its fibular side. In this operation, the principal points to be attended to, are first, in making yonr incision through the origin of the solcus from the tibia; not at the same time to divide the deep fascia of the leg, as this is the line of demarcation between the superficial and deep muscles, and the guide which should be followed to find the artery upon the latter. Secondly, when about to apply the ligature around the artery, the leg should be flexed upon the thigh, to relax the superficial layer of muscles; and the foot extended, to relax the deep-seated.

If the *peroneal ramulus* requires to be tied, much the same steps as in the last operation, are to be followed upon the outer, instead of the inner side of the leg.

The *anterior tibial ramus*—may be secured in any part of its course, which is marked by a line drawn from the anterior edge of the head of the fibula, to the interspace between the metatarsal bones of the great toe and toe next to it.

When it is to be tied in the upper part of the leg, an incision three inches in length, is to be made in the course of the above-named line, through the skin, down to the fascia; when an opaque white line may be seen and felt marking the separation between the tibialis anticus, and extensor longus digitorum muscles. This fascia is next to be cut through, to the extent of the external incision; and when the muscles are separated from each other, the artery will be exposed, resting upon the interosseous ligament, accompanied by its veins on either side of it, and its nerve which is in front of it. The foot should now be flexed upon the leg, and the artery being separated from its veins and nerve, the ligature may be passed around it.

Should it be necessary to tie this vessel in the remaining portion of its course, in a surgical point of view nothing farther is to be considered; but in an anatomical point of view, it is to be remembered that different muscles form its boundaries; which has been already pointed out, in the descriptive anatomy.

The same treatment is required for wounds of the arteries of the foot, which has been already recommended in speaking of the arteries of the hand.

With respect to the medical treatment of patients, who are about to submit to an operation for the radical cure of aneurism, it in general happens, that no previous time is afforded for much to be done, as to the improvement of their constitutions; as the surgeon is generally called upon to afford immediate relief, by an operation. But should time be allowed, the patient should be kept in the recumbent posture, the limb warmly clothed, and placed in such a position as will facilitate its circulation through collateral vessels, in order that they may become enlarged so as more readily to accommodate themselves to the change which will be produced by the operation.

Great attention should be paid to the state of the bowels; and with respect to regimen, it should be sufficiently nutritious as not to reduce the strength of the patient, and not too stimulating so as to increase the action of the heart and arteries.

The treatment after an operation for aneurism, is much the same as that which is adopted previously; subjected, however, to variety depending upon local and constitutional circumstances. For instance, in some cases the whole sac will slough, when the surgeon is called upon to judge as to the propriety of amputating the limb: this will depend upon the power of the constitution; which, if the surgeon thinks sufficient, he will support it with tonics; but if he considers his patient unable to bear up against nature's mode of reparation, he must sacrifice the limb, to preserve life.

The patient is not to be considered out of danger, until the ligature has separated, which occurs at different periods, depending upon the size of the artery; in large arteries, this generally happens between the fourteenth and twentieth days, depending in some measure, also, upon the constitution of the patient, and whether or not any other parts happen to have been included within the ligature. Should there be any delay in the separation of the ligature, the surgeon should not by any means attempt to hasten it; as it appears to be a provision in nature, not to throw off the ligature before she has obliterated the artery by adhesive inflammation: for it is to be borne in mind, that secondary hæmorrhages most frequently occur upon the separation of the ligature, and particularly when unnecessarily disturbed.

TABLE OF THE ARTERIES.

HEART. { PULMONARY TRUNK.
AORTIC TRUNK.

The Aortic Trunk is divided into Four Portions:

ASCENDING, ARCHED, THORACIC, AND ABDOMINAL.

ASCENDING AORTA.

1. ARTERIA CORONARIA DEXTRA, VEL ANTERIOR.
A. *Ramus superior.*
B. *Ramus inferior.*
C. *Ramus posterior.*
2. ARTERIA CORONARIA SINISTRA, VEL POSTERIOR.
A. *Ramus superior.*
B. *Ramus inferior.*

ARCH OF THE AORTA.

3. ARTERIA INNOMINATA.
A. *Ramus thyroideus medius.*
4. ARTERIA CAROTIDIS COMMUNIS SINISTRA.
4. ARTERIÆ CAROTIDES COMMUNES.
5. ARTERIA SUBCLAVIA SINISTRA.
A. *Ramus carotidis externus.*
a. Ramulus thyroideus superior, vel descendens.
α. Ramusculus hyoideus.
β. Ramusculus laryngeus.
γ. Ramusculus thyroideus.
b. Ramulus maxillaris, vel facialis externus.
α. Ramusculus palati inferior, vel ascendens.
β. Ramusculus tonsillaris.
γ. Ramusculi glandulares.
δ. Ramusculus submentalis.

  - ε. Ramusculi masseteres.
  - ζ. Ramusculus labialis inferior.
  - η. Ramusculus labialis superior, vel coronarius.
  - ϑ. Ramusculus lateralis nasi.
  - ι. Ramusculus angularis.
- *c.* Ramulus lingualis.
  - α. Ramusculus hyoideus.
  - β. Ramusculus dorsalis linguæ.
  - γ. Ramusculus sublingualis.
  - δ. Ramusculus raninus.
- *d.* Ramulus occipitalis.
- *e.* Ramulus auricularis posterior, vel stylo mastoideus.
  - α. Ramusculus stylo mastoideus.
  - β. Ramusculus membrana tympani.
- *f.* Ramulus pharyngis ascendens, vel inferior.
  - α. Ramusculus meningeus.
- *g.* Ramulus temporalis superficialis.
  - α. Ramusculus parotideus.
  - β. Ramusculus articularis.
  - γ. Ramusculus transversus facialis.
  - δ. Ramusculus profundus temporalis.
  - ε. Ramusculus temporalis anterior.
  - ζ. Ramusculus temporalis posterior.
- *h.* Ramulus maxillaris internus.
  - α. Ramusculus meningeus medius, vel spheno spinalis.
  - β. Ramusculus maxillaris inferior, vel dentalis.
  - γ. Ramusculi capsulares.
  - δ. Ramusculi masseteres.
  - ε. Ramusculi buccales.
  - ζ. Ramusculi pterygoidei.
  - η. Ramusculi temporales profundi posteriores.
  - ϑ. Ramusculi profundi temporales anteriores.
  - ι. Ramusculus dentalis, vel maxillaris superior.
  - κ. Ramusculus infra orbitalis.
  - λ. Ramusculus palatinus superior, vel descendens.
  - μ. Ramusculus nasalis vel spheno palatinus.

- B. *Ramus carotidis internus, vel cerebralis.*
  - *a.* Ramulus opthalmicus.
    - α. Ramusculus lacrymalis.
    - β. Ramusculus centralis retinæ.
    - γ. Ramusculus supra-orbitalis.
    - δ. Ramusculi ciliares.
    - ε. Ramusculi musculares.
    - ζ. Ramusculus æthmoidalis posterior et anterior.
    - η. Ramusculus palpebralis superior et inferior.
    - ϑ. Ramusculus nasalis.
    - ι. Ramusculus frontalis.
  - *b.* Ramulus communicans posterior.
  - *c.* Ramulus cerebri anterior.
    - α. Ramusculi corporis callosi.
  - *d.* Ramulus cerebri medius.

5. ARTERIÆ SUBCLAVIÆ.

- A. *Ramus vertebralis.*
  - *a.* Ramulus meningeus occipitalis.
  - *b.* Ramulus spinalis posterior.
  - *c.* Ramulus spinalis anterior.
  - *d.* Ramulus cerebelli inferior, vel posterior.
  - *e.* Ramulus basilaris.
    - α. Ramusculus cerebelli anterior, vel superior.
    - β. Ramusculus cerebri posterior.
- B. *Ramus axis thyroideus.*
  - *a.* Ramulus thyroideus inferior, vel ascendens.
  - *b.* Ramulus cervicalis ascendens.
  - *c.* Ramulus transversalis, vel superficialis colli.
    - α. Ramusculus cervicalis superficialis.
    - β. Ramusculus scapularis posterior.
  - *d.* Ramulus supra scapularis.
- C. *Ramus mammillaris internus.*
  - *a.* Ramuli intercostales.
  - *b.* Ramulus comes nervi phrenici.
  - *c.* Ramulus diaphragmaticus, vel phrenicus.
  - *d.* Ramulus abdominalis.
- D. *Ramus intercostalis superior.*

- *a.* Ramulus posterior.
- *b.* Ramulus externus.

E. *Ramus cervicalis profundus, vel posterior.*
- *a.* Ramulus anastomoticus.

5. ARTERIA AXILLARIS.

A. *Ramus thoracicus acromialis.*
- *a.* Ramulus superior.
- *b.* Ramulus inferior.

B. *Ramus thoracicus supremus.*

C. *Ramus thoracicus longus.*

D. *Ramus thoracicus alaris.*

E. *Ramus subscapularis.*
- *a.* Ramulus anterior.
- *b.* Ramulus posterior.

F. *Ramus articularis, vel circumflexus posterior.*

G. *Ramus articularis, vel circumflexus anterior.*

5. ARTERIA BRACHIALIS.

A. *Ramus profundus superior.*

B. *Ramus profundus inferior.*

C. *Ramus anastomoticus magnus.*

D. *Ramus nutritius humeri.*

E. *Ramus radialis.*
- *a.* Ramulus recurrens radialis.
- *b.* Ramulus superficialis volæ.
- *c.* Ramulus anterior carpi radialis.
- *d.* Ramulus dorsalis carpi radialis.
- *e.* Ramuli dorsales pollicis.
  - *α.* Ramusculus dorsalis indicis.
- *f.* Ramulus magnus, vel princeps pollicis.
- *g.* Ramulus radialis indicis.
- *h.* Ramulus palmaris profundus.

F. *Ramus ulnaris.*
- *a.* Ramuli recurrentes anteriores.
- *b.* Ramulus interosseus.
  - *α.* Ramusculi recurrentes interossei anteriores.
  - *β.* Ramusculus interosseus anterior.
  - *γ.* Ramusculus interosseus posterior.

- *c.* Ramuli carpi ulnares anteriores, et posteriores.
- *d.* Ramulus communicans, vel profundus.
- *e.* Ramulus palmaris superficialis.
  - α. Ramusculi digitales.

THORACIC PORTION OF THE AORTA.

6. ARTERIÆ BRONCHIALES.
7. ARTERIÆ ŒSOPHAGEÆ.
8. ARTERIÆ INTERCOSTALES.
   - A. *Ramus dorsalis.*
   - B. *Ramus anterior, vel intercostalis proprius.*
     - *a.* Ramulus superior.
     - *b.* Ramulus inferior.

ABDOMINAL PORTION OF THE AORTA.

11. ARTERIA VEL AXIS CÆLIACA.
    - A. *Ramus gastricus, vel coronarius ventriculi.*
      - *a.* Ramulus superior.
      - *b.* Ramulus inferior.
    - B. *Ramus hepaticus.*
      - *a.* Ramulus pyloricus.
      - *b.* Ramulus gastricus inferior dexter.
      - *c.* Ramulus hepaticus dexter.
        - α. Ramusculus cysticus.
      - *d.* Ramulus hepaticus sinister.
    - C. *Ramus splenicus.*
      - *a.* Ramuli pancreatici.
      - *b.* Ramulus gastricus inferior sinister.
      - *c.* Ramuli breves.
12. ARTERIA MESENTERICA SUPERIOR.
    - A. *Ramus colicus superior dexter.*
      - *a.* Ramulus anastomoticus sinister.
      - *b.* Ramulus anastomoticus dexter.
    - B. *Ramus colicus medius dexter.*
      - *a.* Ramulus anastomoticus superior.
      - *b.* Ramulus anastomoticus inferior.
    - C. *Ramus colicus inferior dexter.*

- *a.* Ramulus anastomoticus superior.
- *b.* Ramulus anastomoticus inferior.
- *c.* Ramulus ileo colicus.

D. *Rami mesentericæ.*

16. ARTERIA MESENTERICA INFERIOR.
  - A. *Ramus colicus superior sinister.*
    - *a.* Ramulus anastomoticus superior.
    - *b.* Ramulus anastomoticus inferior.
  - B. *Ramus colicus inferior sinister, vel sigmoideus.*
    - *a.* Ramulus anastomoticus superior.
    - *b.* Ramulus anastomoticus inferior.
  - C. *Ramus hæmorrhoidalis superior, vel internus.*

9. ARTERIA PHRENICA DEXTER.
  - A. *Ramus anterior dexter.*
  - B. *Ramus externus dexter.*

10. ARTERIA PHRENICA SINISTRA.
  - A. *Ramus anterior sinister.*
  - B. *Ramus externus sinister.*

13. ARTERIÆ CAPSULARES.

14. ARTERIÆ RENALES, VEL EMULGENTES.
  - A. *Rami capsulares inferiores.*

15. ARTERIÆ SPERMATICÆ.

17. ARTERIÆ LUMBALES.
  - A. *Rami spinales.*
  - B. *Rami posteriores.*
  - C. *Rami anteriores.*

18. ARTERIA SACRA MEDIA.

19. ARTERIÆ ILIACÆ COMMUNES.

19. ARTERIA ILIACA INTERNA.
  - A. *Ramus ilio lumbalis.*
    - *a.* Ramulus ascendens.
    - *b.* Ramulus descendens.
    - *c.* Ramulus externus.
  - B. *Ramus sacri lateralis.*
    - *a.* Ramuli posteriores.
    - *b.* Ramuli interni.
  - C. *Ramus hæmorrhoidalis medius.*

- D. *Rami vesicales.*
- E. *Ramus umbilicalis.*
- F. *Ramus uterinus.*
- G. *Ramus vaginalis.*
- H. *Ramus obturatorius.*
  - *a.* Ramuli interni.
  - *b.* Ramuli externi.
- I. *Ramus gluteus.*
  - *a.* Ramulus superficialis.
  - *b.* Ramulus profundus.
    - α. Ramusculus nutritius.
    - β. Ramusculi superiores.
    - γ. Ramusculi medii.
    - δ. Ramusculus inferior.
- K. *Ramus ischiadicus.*
  - *a.* Ramulus coccygeus.
  - *b.* Ramulus comes nervi ischiadici.
  - *c.* Ramuli musculares.
- L. *Ramus pudicus internus.*
  - *a.* Ramuli hæmorrhoidales externi.
  - *b.* Ramulus perinæi.
  - *c.* Ramulus transversalis perinæi.
  - *d.* Ramulus corporis bulbosi, vel spongiosi urethræ.
  - *e.* Ramulus corporis cavernosi penis.
  - *f.* Ramulus dorsalis penis.

19. ARTERIÆ ILIACÆ EXTERNÆ.
- A. *Ramus epigastricus.*
- B. *Ramus circumflexus ilii.*
  - *a.* Ramulus anterior.
  - *b.* Ramulus posterior.

19. ARTERIA FEMORALIS.
- A. *Ramus epigastricus superficialis.*
- B. *Ramus pudicus superficialis.*
  - *a.* Ramulus superficialis.
  - *b.* Ramulus profundus,
- C. *Ramus circumflexus ilii superficialis.*
- D. *Ramus profundus femoris.*

- *a.* Ramulus circumflexus externus.
  - *α.* Ramusculi ascendentes.
  - *β.* Ramusculi transversales.
  - *γ.* Ramusculi descendentes.
- *b.* Ramulus circumflexus internus.
  - *α.* Ramusculus ascendens.
  - *β.* Ramusculus descendens.
- *c.* Ramulus perforans primus.
- *d.* Ramulus perforans secundus.
- *e.* Ramulus perforans tertius.

E. *Ramus anastomoticus magnus.*

19. ARTERIA POPLITEA.

- A. *Ramus articularis superior internus.*
- B. *Ramus articularis superior externus.*
- C. *Ramus articularis medius, vel azygos.*
- D. *Ramus articularis inferior internus.*
- E. *Ramus articularis inferior externus.*
- F. *Ramus tibialis posticus.*
  - *a.* Ramulus peroneus.
    - *α.* Ramusculus peronæus posterior.
    - *β.* Ramusculus peronæus anterior.
  - *b.* Ramulus plantaris internus.
  - *c.* Ramulus plantaris externus.
    - *α.* Ramusculi perforantes.
    - *β.* Ramusculi digitales.
- G. *Ramus tibialis anticus.*
  - *a.* Ramulus recurrens.
  - *b.* Ramulus malleolus internus.
  - *c.* Ramulus malleolus externus.
  - *d.* Ramulus tarsalis.
  - *e.* Ramulus metatarsalis.
  - *f.* Ramulus communicans.
  - *g.* Ramulus pollicis.

LECTURE XXVIII.

DESCRIPTIVE ANATOMY OF THE VEINS.

The veins are the vessels which convey the blood, that has not been expended in secretion and nutrition, back again to the heart; they therefore differ from the arteries in commencing from every part of the body, and terminating at the heart, from whence the arteries commence. It may also be observed, that the veins are more numerous than the arteries; and generally two or more accompany each arterial ramus, and minuter distribution: besides which there are others, that take their course superficially, unaccompanied by the arterial system.

In the description of the veins, I shall commence with the ramifications, which unite to terminate in venous ramusculi, ramusculi in ramuli, ramuli in rami, rami in veins, and veins in seven terminating trunks which open into the heart. There are besides these, however, the sinuses of the brain, and the vena portæ of the liver, which have peculiar distributions, and are described with the organs to which they belong.

The four pulmonary venous trunks, which arise by minute ramifications within the lungs, and terminate in the left auricle of the heart, into which they convey the decarbonized blood, have already been described in the descriptive anatomy of the organs of respiration. (*Vide* p. 186, Vol. III.) We have therefore now to consider the origins and formation of the coronary, superior cava, and inferior cava, which are the three remaining venous trunks.

The blood which is conveyed to the substance of the heart by the coronary arteries, is returned by one venous trunk—

Vena coronaria.—The ramifications which commence from the termination of the coronary arteries, collect themselves into rami venosi, and take their course with the superior and inferior coronary rami of the right and left coronary arteries, where they may indeed be described as right and left venous coronary rami; but they then proceed along the base of the heart; and ascending in the groove which separates the auricles from the ventricles, they unite to form one trunk, which terminates in the right auricle, above and to the left of the auriculo ventricular opening, between it and the fossa ovalis, being there furnished with a valve.

Of the Veins which form the Superior Cava.

This venous trunk conveys back again the blood which has been distributed from the heart, to the head, neck, upper extremities, and part of the chest, by the arteries sent off from the arch of the aorta.

The blood is returned from the head and neck by two venous rami: namely, ramus venosus jugularis internus, and externus.

Ramus venosus jugularis internus—extends from the fossa jugularis of the temporal bone, downwards to the lower part of the neck, where it terminates by uniting with the subclavian ramus to form the vena innominata; on the right side, it descends nearly perpendicularly to the vena cava; and on the left, it almost forms a right angle. In this course the ramus jugularis internus passes within the carotid sheath, on the outer side of the common carotid artery and pneumo-gastric nerve. It receives, above, the sinuses which return the blood from the brain, and which pass out of the foramen lacerum basis cranii on either side, and terminates in the commencement of this ramus at the fossa jugularis. It then receives the ramulus venosus facialis, which conveys the blood back towards the heart which had been distributed by the ramulus maxillaris, arteriæ carotidis: therefore to comprehend the manner in which the blood of this ramulus is collected, it is only necessary to refer to the distribution of the external maxillary arterial ramulus, when it will be seen that the accompanying venous ramuli are, ramusculi venosi angulares, r. v. laterales nasi, r. v. labialis superior, et inferior, r. v. masseteres, r. v. submentales r. v. glandulares, r. v. tonsillares, and r. v. pallati inferiores: these uniting, form the ramulus venosus facialis, which is directed obliquely downwards and backwards, over the horizontal plate of the lower jaw, covered by the platysma myoides muscle; and being placed between it and the submaxillary gland, and behind and to the outer side of this gland, it terminates in the ramus venosus jugularis internus.

Ramulus venosus lingualis—collects its blood from the ramusculi venosi ranini, r. v. sublingualis, r. v. dorsalis linguæ, and r. v. hyoidei, and descends between the sublingual gland and the genio glossus muscle; then between the hyo glossus and mylo hyoideus muscles; passes backwards and outwards, accompanying the arterial ramulus above the cornu of the os hyoides, to terminate in the internal jugular ramus venosus.

Ramulus venosus thyroideus superior—receives its blood from the ramusculi venosi thyroidei, r. v. laryngei, and r. v. hyoidei: it then takes its course not unfrequently in two ramuli, with the arterial ramusculus; and terminates, either singly or separately, in the internal jugular. Some venous ramusculi from the pharynx usually will be found forming a single ramulus venosus pharyngeus, which empties itself in the internal ramus venosus jugularis.

Ramuli venosi occipitales—collect their blood from the corresponding arterial vessels, following their course so completely as to need no farther description. They terminate in the internal ramus venosus jugularis.

Besides these venous ramusculi, others arise within the diploe of the bones of the skull, which pass indirectly into the internal jugular ramus: for instance, in front, by the frontal ramusculi venosi of the facial ramulus; behind, by the ramusculi venosi of the occipital ramulus, and in part by the sinuses of the brain: thus completing the ramus venosus jugularis internus.

Ramus venosus jugularis externus—is formed by the venous ramusculi, which return the blood from the face and sides of the head, and which had been conveyed by the terminating ramusculi of the external carotid arterial ramus.

Ramulus venosus temporalis superficialis—receives the blood of the ramusculi venosi temporales posteriores, r. v. temporales superiores, r. v. profundi temporales, r. v. transversales facii, r. v. articulares, and r. v. parotidei; it then descends in front of the ear, receiving some ramusculi venosi auriculares anteriores, and unites with the—

Ramulus venosus maxillaris internus.—This ramulus is made up of the ramusculi venosi nasales, r. v. palati superiores, r. v. infra orbitales, r. v. dentales, r. v. temporales profundi posteriores, r. v. pterygoidei, r. v. buccales, r. v. capsulares, and r. v. maxillares inferiores, and passes behind the cervix of the lower jaw, in the substance of the parotid gland, and there unites with the last described ramulus, forming together the commencement of the ramus venosus jugularis externus—which very frequently immediately receives the ramusculi auricularis posteriores, and then descends along the side of the neck, being placed between the sterno-cleido mastoideus and platysma myoides muscles. It next passes, rather deeper seated, behind the omo hyoideus muscle, and parallel with the outer edge of the sterno-cleido mastoideus; usually behind which it opens in the ramus venosus subclavius, to the outer side of the termination of the ramus venosus jugularis internus. In this course, several cervical cutaneous ramusculi empty themselves into this ramus, more especially at the lower part of the neck, just before its termination.

At the angle of the jaw, a short but large ramulus venosus passes deeply inwards, to form an anastomosis between the external, and internal jugular rami.

It should be observed, that each of the ramusculi which are distributed from the internal maxillary arterial ramulus are not furnished with a corresponding venous ramusculus: for instance, the blood which is conveyed to the membranes of the brain by the ramusculus arteriosus meningeus medius, is not returned to the ramus venosus jugularis externus by a corresponding venous ramusculus, but is conveyed from the membranes of the brain by the sinuses.

Ramus venosus subclavius.—This ramus conveys the whole of the blood from the upper extremity; but we shall find that the ramuli which unite to form it, do not all take the course of the arterial ramuli; but many of them are much more superficial, and indeed subcutaneous. We will, therefore, first describe the venous distribution which accompanies the arteries of the upper extremity, beginning at the fingers.

Ramusculi venosi digitales—accompanying each digital ramusculus of the arterial system—take their course upward to form the superficial palmar ramuli accompanying the superficial palmar arterial arch, and receiving venous ramuli from all the ramusculi of that as well as of the deep palmar arterial distributions. These all concur to produce—

Rami venosi profundi radiales, et ulnares—which take their course with the arterial rami; receiving, as they pass upward toward the elbow-joint, all the venous ramuli which return the blood from the corresponding arterial distributions; so that, near the elbow-joint, they form four considerable vessels; but having reached that joint, the two radial unite, and the two ulnar venous rami unite, forming two large veins—

Venæ brachiales.—These take their course on either side of the brachial artery frequently anastomosing with each other, and receiving venous rami which are corresponding with the arterial rami: as for instance, rami venosi anastomotici magni, r. v. profundi inferiores, and r. v. profundi superiores. The venæ brachiales thus augmented in size as they pass upward, reach the inferior edge of the teres major muscle, and form in part the vena axillaris, which has also to receive the superficial venous distribution of the upper extremity, as well as the venous rami, accompanying the arterial rami from the axillary artery.

Ramus venosus cephalicus—commences by a number of venous ramusculi on the back of the hand, and particularly about the thumb; upon which so large a branch is found, that it has been named the *ramulus venosus magnus pollicis.* These collect and take their course upward upon the outer and anterior part of the fore arm, parallel with the radius, and is here named the *ramulus venosus radialis superficialis,* which receives numerous subcutaneous venous ramusculi; and on reaching the bend of the elbow it unites with the median cephalic ramulus — together forming the above-named ramus venosus cephalicus, which now ascends vertically parallel to the outer edge of the biceps muscle, then between the outer edge of the pectoralis major, and the inner edge of the deltoid: it terminates by bending inwards under the clavicle, to open into the axillary vein.

Ramus venosus basilicus—is formed in a similar manner as the last described ramus, by venous ramusculi commencing on the inner side of the hand. On the back and inner side of the hand, and posterior surface of the fingers, a net-work of ramusculi is formed, the vessels of which frequently anastomose with each other, as well as with the cephalic ramusculi. On reaching the upper part of the hand, these ramusculi frequently form one large vessel, which has been termed the *vena salvatella,* which continues to the inner and back part of the fore arm, and gains the name of the—

Ramulus venosus ulnaris superficialis posterior.—This ramulus continues its course upwards behind the inner condyle of the humerus, where it is connected with the anterior superficial ulnar ramulus; receiving, however, previous to this union, numerous subcutaneous ramusculi.

Ramulus venosus ulnaris superficialis anterior—originates at the lower part of the inner and anterior part of the fore arm; ascending in front of the ulna, before the internal condyle, to communicate with the last described ramulus. Just above the bend of the elbow, and the union of the posterior and anterior superficial ulnar ramuli, the ramulus basilicus medianus unites, and they together form the ramus basilicus.

The median basilic ramulus, below the bend of the elbow, and in the triangular space between the supinator radii longus on the outer side, and the pronator radii teres muscle on the inner, unites with the median cephalic, at an acute angle: both of them emanating from a vessel named—

Ramulus venosus medianus.—The ramus venosus basilicus then ascends along the inner side of the arm, in front of the ulnar nerve, receiving small subcutaneous ramusculi in its course upwards; anastomosing also with the ramus venosus cephalicus, it passes deeply into the axilla, where it terminates in the—

Vena axillaris—This vein ascends obliquely inwards and upwards, under the clavicle in front of the axillary artery, as high as the first rib, where it becomes the subclavian vein. In this course it receives, however, rami corresponding to the rami of the axillary artery: such as rami venosi circumflexi, r. v. inferiores scapulæ, and the r. v. thoracici. From the anterior edge of the first rib the subclavian vein commences, and extends inwards in front of the scalenus anticus muscle, to terminate within the thorax, (after having received the rami jugulares), in forming the superior cava.

In consequence of the situation of the superior cava on the right side of the chest, there is a considerable difference both in the extent, and direction of the two subclavian veins: the right subclavian vein is very short, and is directed nearly in a vertical direction: it is covered by the sterno cleido mastoideus muscle, sterno clavicular articulation, and the cartilage of the first rib. To its outer side it is bounded by the pneumo gastric nerve, the right subclavian artery, and the scalenus anticus muscle; internally it is bounded by the aorta.

The left subclavian vein is nearly twice the length of the right, and its direction is nearly horizontal, having a slight obliquity downwards and inwards. It is covered, like the right subclavian vein, by the sterno-cleido mastoideus, the sterno clavicular articulation, and the cartilage of the first rib; also by the first bone of the sternum, the sterno-hyoidei and sterno-thyroidei muscles. It is bounded posteriorly by the scalenus anticus muscle, the left subclavian artery, the pneumo gastric nerve, and the arch of the aorta. It is, in fact, the most anterior of all the vessels seen within the cavity of the chest. The left subclavian vein usually receives two venous rami which the right does not, and which we will proceed to describe before those common to both veins.

Ramus venosus mammillaris internus sinister—returns the blood which the corresponding arterial ramus had distributed: it is made up, therefore, of ramuli venosi abdominales, r. v. diaphragmatici, r. v. comites nervi phrenici, and r. v. intercostales. These are collected into a single ramus, which takes its course upwards upon the posterior surface of the cartilages of the ribs; and as it reaches the left subclavian vein, it is directed backwards to terminate in it.

Ramus venosus thyroideus inferior sinister—results from the union of numerous ramuli which pass out of the inferior and posterior surface of the thyroid gland, and descend in front of the trachea, upon which they enter the chest, and terminate in the left subclavian vein.

The remaining rami to be described, are common to both subclavian veins, and are the vertebral and superior intercostal rami.

Ramus venosus vertebralis—is made up of ramuli corresponding to the distributing ramuli of the arterial ramus. It commences principally by small ramuli from muscles in the occipital and posterior cervical regions, and there forms itself into a large trunk, which takes its course with the vertebral artery upon the posterior circular ligament between the atlas and occiput; it passes forwards to gain the foramen at the root of the transverse process of the atlas, near to which it is united with the lateral sinus of the dura mater, by a venous ramulus, which passes through the posterior condyloid foramen. The ramus venosus vertebralis then descends through the canal formed by the transverse processes of all the cervical vertebræ, being accompanied by its corresponding artery. In this course it anastomoses internally, through the intervertebral foramina with the sinus venosus; and externally, it receives in each intervertebral space, venous ramuli from the muscles of the neck. This ramulus issues from the canal of the seventh cervical vertebra, and descends by the side of its accompanying arterial ramulus, between the rectus capitis anticus major on its inner side, and the scalenus anticus on the outer. In this space receiving venous ramuli returning the blood from the ramulus cervicalis profundus; then it passes, on the left side before the subclavian artery, and on the right side behind that vessel, to terminate in the subclavian vein.

Ramus venosus intercostalis superior dexter—is very small, and sometimes wanting; it commences by corresponding ramuli of the superior right arterial intercostal ramus, from the two or three upper intercostal spaces, which uniting, form one ramus, opening into the right subclavian vein.

Ramus venosus intercostalis superior sinister—is always much larger than the right, commencing by ramuli as low down as the eighth intercostal space; it enlarges as it ascends, anastomosing with the vena azygos, and receiving venous ramuli from each intercostal space above the eighth; it passes on the sides of the bodies of the vertebræ behind the pleura, behind the lung and aorta; and near to the third cervical vertebra, just to the outer side of the arch of the aorta, it receives—

Ramulus venosus bronchialis sinister—immediately after which, it passes out of the chest, and terminates in the under part of the left subclavian vein. That portion of the subclavian veins, included between the entrance of the internal jugulars and their termination in the superior cava, has by some anatomists been termed the venæ innominatæ; so that the formation of the superior cava would be considered as resulting from the union of the two venæ innominatæ; and by others, by the union of the two venæ subclaviæ.

The vena cava superior—formed as we have described it, commences opposite to the cartilage of the first rib on the right side, to the right and rather above the arch of the aorta; from thence it descends to terminate in the right auricle of the heart, passing obliquely downwards and inwards; but before it reaches the heart, it enters the pericardium, by which it gains a distinct serous covering. This venous trunk is bounded anteriorly, by the anterior mediastinum, and its contents; posteriorly, by the superior right pulmonary vein, and right pulmonary artery; to the right, by the lung; and to the left, by the ascending aorta. In this course, before entering the pericardium, it receives the following venous rami.

Ramus venosus mammillaris internus dexter.—The description of this ramus corresponds in every circumstance with that of the left side, excepting in its terminating in the cava, instead of the subclavian vein.

Ramus venosus thyroideus dexter.—This branch results from the union of the thyroid venous plexus, just in the same manner as on the left side, and passes downwards in front of the subclavian artery; takes its course to the right, behind the sterno-hyoidei and sterno-thyroidei muscles, to terminate in the upper part of the superior cava, between the two subclavian veins.

Ramus venosus azygos—results from the union of ten or eleven of the intercostal venous ramuli of the right side, and the five or six inferior of the left, communicating below with one of the superior lumbar veins—thus producing a communication between the superior and inferior cavæ. Commencing the description of this ramus from the abdomen, it passes upwards between the pillars of the diaphragm, in the same opening with the aorta and thoracic duct; it ascends upon the bodies of the vertebræ within the posterior mediastinum, to the right of the aorta and thoracic duct, and in front of the right intercostal arteries. Having reached the third dorsal vertebra, it bends backwards behind the arch of the aorta, directs itself to the right, passes behind the right bronchus, above which it rises, passes forwards and downwards so as to hook around the bronchus, and terminates in the superior cava. In this course, it receives, first, within the abdomen, as has been mentioned, some venous lumbar ramuli from the inferior cava, or from the renal vein; while in the chest, on the dorsal vertebræ, it not only receives all the rami venosi intercostales of the right side, but upon the seventh dorsal vertebræ, there opens into it—

Ramus semi-azygos—a branch made up of the six inferior left intercostal ramuli, which crosses the eighth dorsal vertebra from left to right, behind the aorta and œsophagus, receiving venous ramuli from each of these organs; and, lastly, just before it opens into the superior cava, it receives the—

Ramus venosus bronchialis dexter.—This ramus is made up of numerous small ramuli, proceeding from the right lung, œsophagus, trachea, pericardium, and bronchial glands—thus completing the formation of the superior cava.

Of the Venous Distributions which concur in forming the Trunk of the Vena Cava Inferior.

This trunk returns the blood to the heart which has been distributed by the abdominal aorta, with the exception of that portion, which is returned from the chylopoetic viscera, by the vena portæ.

As in the upper extremity, the veins of the lower are divided into two sets—one following the course of the arteries, and the other being subcutaneous. I shall therefore describe them in a similar order.

First, the deep veins commence in the foot, bearing the same names as the arterial ramusculi which they accompany. Thus the ramusculi venosi digitales, and ramusculi venosi perforantes, unite to form the *ramuli plantares.* They take their course backwards, from the foot to the internal malleolus; where they unite, and form the *ramus venosus tibialis posticus.* This takes its course upwards with the artery, to gain the popliteal space, where it terminates in the popliteal vein. In its course along the leg, it receives the *ramuli venosi peronei posteriores, et anteriores.*

From the fore part of the dorsum of the foot, ramuli venosi pollicis, r. v. communicantes, r. v. metatarsales, r. v. tarsales, r. v. malleoli externi, et interni, and r. v. recurrentes, together contribute to form the *rami venosi tibiales antici;* for there are two which accompany the artery—taking its course upon the anterior surface of the interosseous ligament, and ascending as high as the upper hiatus; then pass through it with the artery, and terminate in the popliteal vein.

The popliteal vein also receives the following superficial subcutaneous venous ramus.

Ramus saphenus externus — commences by numerous ramuli from the outer side and back part of the foot, which ascend both anterior, and posterior to the malleolus externus, and unite above it in a single trunk, which directs itself to the posterior part of the calf of the leg; passing vertically upwards, between the integuments and fascia, gains the interspace between the two heads of the gastrocnemius muscle; then passes into the hollow of the ham, and terminates in the popliteal vein.

Vena poplitea—takes its course with the popliteal artery, being placed behind and to its outer side, and extends with it from the lower edge of the popliteus muscle to the tendinous sheath formed by the vastus internus and adductor magnus; at which point, this vein, as well as the artery, terminate by becoming femoral.

In this course, the popliteal vein receives also the five sets of *ramusculi venosi articulares.*

Vena femoralis—commences from the termination of the popliteal, as above described, and passes upwards to

Poupart's ligament, taking the course of the femoral artery, and terminates by becoming the external iliac vein. In this course, it receives the deep branches which accompany the arteries; namely, rami venosi anastomotici magni, ramuli venosi perforantes tertii, secundi, et primi, r. v. circumflexi externi et interni; ramus venosus profundus femoris, rami pudici superficiales, and rami venosi epigastrici superficiales. But besides these deep veins, it also receives—

Ramus venosus saphænus internus.—This commences by numerous ramuli upon the inner, back part, and dorsum of the foot, which form anastomoses with the ramus saphænus externus; the ramifications unite, pass upward, surrounding the malleolus internus, receiving tarsal ramuli, and then form a single ramus above the ankle, which ascends obliquely upwards and backwards along the inner side of the leg, passes behind the internal condyle of the femur to gain the thigh, from whence it passes upwards upon the inner side of the thigh, anterior to the adductors, and gracilis muscle, receiving numerous superficial cutaneous ramuli from the posterior part of the thigh, more especially upon the fore part of the internal condyle, where large vessels are seen to connect themselves with this ramus. The ramus saphenus continues to ascend, between the skin and fascia on the inner and fore part of the thigh, as high as the crescentic margin of the fascia lata; and here it perforates the fascia propria, or anterior layer of the sheath of the femoral vessels, to terminate in the femoral vein.

The ramus saphenus, just before it terminates, receives some small superficial ramuli from the abdomen, and from the superficial pudic venous distribution.

The *vena iliaca externa*—commence at the termination of the femoral vein at Poupart's ligament, and extends upwards to the sacro-iliac symphysis, where it terminates in the common iliac vein. In this course, it accompanies the external iliac artery, which is anterior and to the outer side of it. It receives the rami venosi circumflexi ilii, and the rami venosi epigastrici, formed by ramuli accompanying the distributions of the corresponding arteries: also a branch of considerable size in the male subject, which passes out of the inguinal canal, through the internal ring; which vessel seems to correspond with the arterial ramification from the epigastric, which supplies the cremaster muscle.

Vena iliaca interna, vel hypogastrica.—The venous rami which unite to form this vein, may be divided, as the ramifications of the corresponding artery, into those which return the blood from the muscles within the pelvis, those from the viscera within the pelvis, and from the parts without the pelvis.

The first order constitutes the rami venosi sacri-laterales, and the rami venosi ilio lumbales. The second order are the rami venosi vaginales, r. v. uterini, r. v. umbilicales, r. v. vesicales, and ramus hæmorrhoidalis medius. The third order are the rami venosi glutei, the r. v. pudici externi, the r. v. ischiadici, and the r. v. obturatores; which are severally produced from the venous ramifications, corresponding to the respective arterial distributions.

These three orders unite, and form a short large vein, placed in the hollow of the pelvis, behind its corresponding artery; and just at the upper part of the sacro-iliac symphysis, it unites with the external iliac vein, which has already been described, to form the—

Vena iliaca communis.—There is some little anatomical distinction between the right and left iliac veins; although they are both resulting from the union of the external and internal iliacs.

The left common iliac vein, in passing upwards and to the right to terminate in the inferior cava, has a longer course to run than the vein on the right side, is also more obliquely placed, and has to pass behind the right common iliac artery.

These veins extend from the sacro-iliac symphysis, upwards, to the junction between the fourth and fifth lumbar vertebræ, where they unite to form the trunk of the inferior cava; in this course, receiving only some few unimportant venous rami.

The *vena cava inferior, vel abdominalis*—extends from the junction of the fourth and fifth lumbar vertebræ, to the right auricle of the heart, in which it terminates. In this course, it ascends vertically on the right side of the bodies of all the lumbar vertebræ; being first covered by the right common iliac artery, then by the reflections of the peritoneum, then by the duodenum, and then passes behind the liver, in a groove in that organ, between the right lobe, and the lobulus spigelii; it next perforates the cordiform tendon of the diaphragm, and entering the thorax, it is covered by the pericardium, and almost immediately enters the auricle of the heart by an aperture bounded by the eustachian valve. It is placed to the right of the aorta, and in this course receives the following venous rami.

Venæ sacræ mediæ—correspond with the arterial ramifications, pass upward upon the anterior surface of the os sacrum, and terminate in an angle resulting from the union of the two common iliacs into the cava.

Venæ lumbales—are four in number on each side, and each results from four rami venosi anteriores, posteriores et spinales; they anastomose, above, with the intercostal venous rami, and below, with the ramus venosus circumflexus ilii. Those of the left side, are much longer than those of the right, and pass behind the aorta. These veins frequently anastomose with each other on the fore part of the transverse processes of the lumbar vertebræ.

Vena spermatica dexter—terminates in the abdominal cava, but on the left side it opens into the left emulgent vein. These veins commence in the male upon the tunica vasculosa of the testicle, form the spermatic plexus of veins, pass upward upon the spermatic cord in four or five distinct branches, enveloping the spermatic artery, and vas deferens, pass through the external abdominal ring, inguinal canal, and internal abdominal ring, and then unite and form a single vein which takes its course upwards along the psoas muscle, and approaches the kidney, where it receives veins from the renal plexus; from this, however, the spermatic vein continues its course to terminate, as has been described, on the right side in the cava, and on the left, in the emulgent vein. In the female, the spermatic veins commence from the ovaria, from whence they pass to terminate in a similar manner.

Venæ renales, vel emulgentes—are of great size, but not so large in proportion to their arteries as other veins. They result from the union of ramifications, corresponding with the distributions of the renal arteries; and unite to form one trunk, in the fissure of the kidney; from whence it passes, transversely inwards, to open into the inferior cava. The left emulgent vein is longer than the right, and has to cross in front of the aorta to gain the cava; it also differs from the right in receiving the left spermatic vein. Both renal veins receive the inferior rami venosi capsulares.

The *rami venosi medii capsulares*—arising from the capsula renales, are uncertain in their termination, but very generally open into the. cava, and more particularly on the right side.

The *venæ diaphragmaticæ*—result from the venous ramifications, corresponding to the arterial distribution, and terminate in the cava.

The *venæ hepaticæ*—commence within the substance of the liver, and collect themselves into a right and left hepatic vein, corresponding to the two lobes. They pass out from the organ at its obtuse edge, between the two layers of the lateral ligaments, and open into the cava between the diaphragm and the liver. Between the right and left hepatic vein, generally two or three smaller veins, which have been named the middle hepatic veins, also pass out to terminate in the cava; and thus complete the sources which contribute to the formation of the ascending or inferior cava, which then passes through the cordiform tendon of the diaphragm, and having entered the thorax, immediately opens into the right auricle of the heart. The only remaining veins to be described, are—

Ramuli venosi spinales, vel sinus vertebrales—take the course of the whole of the vertebral canal, from the sacrum to the occiput, behind the bodies of the vertebræ, anterior to the theca vertebralis, and on the sides of the common proper posterior ligament. They commence from the venous ramusculi in the adipose tissue of the sacral canal, and are augmented by ramusculi from the dura mater, enveloping the spinal marrow along the whole length of the spinal column. In this course they anastomose with the venous ramusculi of the lateral sacral, lumbar, and intercostal rami, on their outer sides; and on their inner sides, by short vessels with each other, on the bodies of the vertebræ, underneath the posterior vertebral ligament, where they receive ramusculi from the substance of the bodies of the vertebræ.

These ramuli venosi are called sinuses, because they have short communicating cross-tendinous bands in them, similar to the sinuses of the dura mater. They communicate with the rami jugulares interni, opposite to the anterior condyloid foramina.

The ramuli venosi spinales, appear to contract opposite to the fibro-cartilages, and to enlarge upon the bodies of the vertebræ, hence they have a knotted appearance, which is more particularly observable in the lumbar region.

The diseases of veins, in a surgical point of view, are less important than those of arteries, rarely leading to operations; their frequent communications by collateral branches being the means of restoring the circulation under any interruption to the current of the refluent blood. I therefore do not deem it necessary to enter farther into this subject than I have already done. (*Vide* Vol. III. p. 296.)

LECTURE XXIX.

DESCRIPTIVE ANATOMY OF THE ABSORBENT SYSTEM.

This system consists of the absorbent glands, and the absorbent vessels. Anatomists have considered the latter under the two names of lymphatics and lacteals: terms which in fact merely imply the appearance of their contents; nor indeed do we know any difference, either in their organization or functions, further than that the lacteals convey to the blood the products of digestion, while the lymphatics remove from every part of the body (excepting from the exterior), the excrementitious particles of the system, which is subjected to the action of the lungs, to be fitted for future circulation.

In the physiology of the absorbent system, we have mentioned the general structure and the termination of the absorbents, with their mode of passing over, in, and out, of the absorbent glands (*vide* Vol. III. p. 283); and we remarked, that it appeared to be a law of the animal economy, that the fluids circulated in these vessels should be submitted to the action of the glands, previous to their admission to the circulation of the blood. Whatever the peculiar action of the glands may be, their situation is of great importance to the surgeon, on account of the extensive connection which they frequently hold with the progress of diseases.

Anatomists have usually described the absorbents in sets, conformable to the general course which they appear to take. Following this order, we shall first enumerate the absorbent glands in the different situations of the body in which they are to be found, and then proceed to the course which the absorbent vessels take to be connected with them.

Absorbent glands of the head.—No absorbent gland has been discovered within the cranium; for no absorbent vessel has been traced either to or from the pituitary, pineal, or Pacchionian glands. Two or three absorbent glands are found beneath each ear, and one or two behind the zygomatic arch.

Absorbent glands of the face.—There is generally one situated on the buccinator muscle, and one or two above the parotid gland, and others along the under edge of the lower jaw, lying in the course of the digastric muscle.

Absorbent glands of the neck.—Here the superficial and deep-seated arrangement is more distinct. The superficial are placed immediately under the platysma myoides muscle, in the course of the external jugular vein. The deep-seated are placed in the course of the internal jugular vein, and carotid arteries; and form a chain, from the mastoid process to the upper opening of the thorax, covered by the sterno-mastoid muscle.

These glands are more numerous than in any other situation in the body, excepting the mesentery, and have been named the glandulæ concatenatæ jugulares. There are also one or two near the larynx, a few at the back of the neck, and some smaller ones in the space between the clavicle, the sterno-mastoid, and trapezius muscles.

Absorbent glands of the upper extremity.—It is very unusual to find any gland below the elbow—one or two small ones are found near the inner condyle; from this point five or six are met with at intervals, along the course of the brachial artery.

In the axilla they are much more considerable, both in size and number. They are here embedded in the cellular membrane of the axilla, in connection with the axillary blood-vessels, and nerves. These glands, five or six in number, are connected with others, which extend behind the clavicle, and beneath the pectoralis major.

Absorbent glands of the thorax.—Three or four are found of small size, before the inferior part of the pericardium, above the diaphragm. From four to five are also found at the superior and anterior part of the anterior mediastinum: from six to ten, in the course of the internal mammary artery. Several are placed between the layers of the posterior mediastinum, behind the pericardium, in the whole course of the œsophagus: others forming a chain, which appears to continue from the lumbar glands, are placed along the dorsal vertebræ, and between the posterior extremities of the ribs.

The bronchial glands.—These are numerous, of a dark color in old subjects, and follow the course of the first division of the bronchial tubes, and the interval between the lungs. They vary in size; are sometimes single, at others lobulated. They are filled with a dark fluid; and it is not uncommon to find them filled with chalky concretions.

Some of these glands are situated about the arch of the aorta, between it and the pulmonary artery, where they have been named the cardiac glands—receiving the absorbent vessels of the heart.

Absorbent glands of the lower extremities.—The only gland met with below the knee, is one placed at the upper hiatus of the interosseous ligament, between the tibia and fibula; named the anterior tibial gland. In the popliteal region, three or four accompany the popliteal artery. In the inguinal region, there is a superficial and a deep-seated set: the superficial are placed between the fascia lata and skin, near the termination of the saphæna major vein—they are from six to twelve in number, placed close together; the deep-seated, two or three in number, are placed under the fascia lata, and close to the femoral artery.

Absorbent Glands of the Pelvis.

The internal iliac glands—are from eight to ten in number, following the course of the internal iliac vessels, on the inner side of the cavity of the pelvis. Sometimes one or two are also found in the course of the gluteal, and ischiatic rami.

The *external iliac glands*—from six to ten in number, are situated in the course of the external iliac vessels; some between them and the psoæ muscles, others on the internal side of these vessels. Inferiorly, they extend to the crural arch, and upwards to the glands of the lumbar region; the intervening two or three glands, which connect the external iliac with the lumbar, are placed in the tract of the common iliac arteries.

Sacral glands—are two or three, placed between the sacrum and the rectum, within the layers of the meso-rectum.

Absorbent glands of the abdomen—are more numerous than in any other part of the body, being connected with the extensive absorption of the alimentary canal, and viscera contained within this cavity. They are named according to their connection with these various organs.

The *mesenteric glands*—from one hundred and thirty to one hundred and forty in number, are situated between the layers of the mesentery, arranged at short intervals from each other, occasionally in clusters. They are most numerous in the mesentery of the upper part of the jejunum, decreasing in number downwards. They are seldom larger than an almond—the largest being nearest to the roots of the mesentery.

The *meso-colic glands*—are connected with the colon, and follow the course of that intestine. They are less in size and number, than in the mesentery—five or six on the inner side of the ascending, thirty or more to the transverse arch, the largest of which are at the root of the meso-colon, the smallest at the posterior edge, and six or seven on the inner edge of the descending colon, and fifteen or twenty on the outer; while two or three are met with in the upper part of the meso-rectum.

The *ventricular glands*—are placed along the curvature of the stomach, in the course of the right and left inferior gastric ramuli, the coronary ramus, and of the great, and little omentum. They are small in size, and from five to six in number.

The *cœliac glands*—variable in number, are situated in the course of the vena portæ, cœliac, and superior mesenteric arteries; they are divided into sets, accompanying the rami of the cœliac artery, and are called the hepatic, pancreatic, and splenic glands.

The *lumbar glands*—are large and numerous, accompanying the aorta and vena cava, forming a glandular series, covering the inferior part of the pillars of the diaphragm, and lumbar vertebræ.

Of the Absorbent Vessels.

All the absorbent vessels of the body terminate in the veins, but principally into the venæ innominatæ, at the upper part of the chest, by two large trunks, termed the thoracic ducts. These are the main trunks to the absorbent system, as the aorta and venæ cavæ are to the arterial and venous systems. We shall therefore describe the absorbent vessels, as they pass to form these two terminating trunks in the course of their circulation.

It may be observed, however, that there is a great disparity between the right and left thoracic ducts; the right receiving the absorbents of the right half of the head and neck, of the right upper extremity, of the right half of the parietes and contents of the thorax, and some few only from the liver; while the left, or as it is often named from its larger size, the thoracic duct, receives the absorbents from all the other parts of the body.

This dissimilitude of distribution is not, however, so great as to lead to the necessity of separate descriptions, farther than the deviation which necessarily occurs in the course of the main trunks; as, generally, the mesian line of the body, in the head, neck, trunk, and extremities, is a line of separation to similar ultimate distributions.

Of the absorbent vessels of the head and neck.—The superficial absorbents of the head and neck, may be divided into those from the anterior, middle, and posterior parts of the head and neck.

The *anterior*—arise from the cheeks, lips, inferior eyelid, nose, external surface of the eyelids, fat of the orbit, and the forehead. They take their course with the veins principally, and run toward the glands situated between the anterior belly of the digastric muscle and the lower jaw. Others arise from the mucous membrane of the mouth and tongue, the mylo-hyoideus, and genio-hyoidei muscles, the sublingual, and submaxillary glands, and pass to glands at the base of the lower jaw. The vessels from the anterior parts, take their course to the glands, above and before the jugular vein; and thus pass to terminate in the right and left sides, in their respective thoracic ducts.

The *middle* branches of the superficial absorbents—arise from the summit and lateral parts of the cranium, accompanying the ramifications of the temporal artery; also from the external parts of the palpebræ; and one branch from the cheek accompanies the transverse facial ramusculus. These enter the glands, situated before the ear, and below the zygomatic arch; while those which accompany the temporal ramuli, descend on the external part of the parotid, to the same absorbent gland.

The *posterior* branches—arise from the posterior parts of the head, taking the course of the posterior branches of the temporal ramulus. The auricular and occipital ramusculi, after forming numerous anastomoses, penetrate the glands on the posterior part of the head and neck; they then descend behind the sterno-cleido mastoideus; some branches arising from the substance of that muscle, and pass to the glands placed at the lateral and inferior part of the neck, between the trapezius and sterno-cleido mastoideus, and to those glands which are situated in the course of the jugular vein, near to its bifurcation.

The *absorbent vessels, deeply seated in the head and neck*—are arranged in an anterior and a posterior set.

The *anterior*—arise from the larynx, pharynx, and thyroid glands, accompanying the superior thyroideal, and ascending pharyngeal ramuli. They sometimes enter small glands on the upper and fore part of the thyroid, and cricoid cartilages, the superior thyroideal at the same time passing to glands situated on the fore part of the trachea.

The *posterior*—arise from the back part, and posterior muscles of the neck, accompanying the ascending ramusculus of the posterior cervical ramus; they enter glands, in the course of the internal jugular vein with the vessels of the anterior part.

The deep-seated absorbents of the cranium, have not been traced beyond the membranes of the brain; but there is no doubt that they exist, as the ventricles contain a fluid, which is constantly secreted and absorbed—the absorbents being the only vessels from which the latter effect may be supposed to arise. These absorbents pass out of the cranium with the blood-vessels, and join the superficial absorbents of the head and neck.

The trunks both of the superficial and deep-seated absorbents, freely communicate with each other, and with those from the chest and upper extremity; finally forming one, or more trunks, which terminate in the upper part of the thoracic duct, at the angle formed by the internal jugular and subclavian veins.

Superficial absorbents of the upper extremity.—These arise from the fingers, and ascend on the fore and back part of the hand, and fore arm, where they form a freely anastomosing plexus. They then pass over the muscles on the radius and ulna, to the inner and fore part of the arm, and are all situated anteriorly at the bend of the elbow; where they unite with three or four vessels, which ascend more particularly from the palm of the hand, and anterior part of the fore arm. They then pass through the glands above the elbow, and from thence on the inner side of the arm to the axilla, where they unite with the axillary glands. Some few accompany the cephalic vein, and reach the axilla by passing between the deltoid and pectoralis muscles.

Deep-seated absorbents of the upper extremity.—These accompany the arterial distributions, and are commonly two in number to each of the larger rami of the fore arm; they afterwards unite into trunks, which continue with the brachial artery, to terminate in the axilla—uniting freely with the superficial set.

Absorbents of the parietes of the thorax—arise from the anterior, lateral, and posterior parts, and are distributed in a superficial and deep-seated arrangement.

Of the *superficial.*—The anterior and lateral, arise from the corresponding parietes of the thorax, sending branches which unite with the absorbents of the cavity. They take their course, from the upper part, over the pectoralis major, and from the lower part and sides, over the serratus magnus and obliquus externus abdominis muscles, to reach the axilla; where they unite with the axillary glands. From the posterior part of the trunk, they take their course from the whole surface of the back—the greater number running over the trapezius muscle, through which they pass to the glands of the axilla.

The *deep-seated absorbents*—are the intercostals: they arise from the external muscles, and cellular tissue of the thorax; then pass deeply to the glands between the layers of the intercostal muscles, and then to the sides of the vertebral column, where they join with the absorbents of the spine, and muscles of the back; forming a plexus upon the vertebræ, and terminating obliquely in the thoracic duct.

Absorbent Vessels of the Viscera, and parts within the Thorax.

Absorbents of the lungs.—These form a superficial and deep-seated set.

The *superficial*—are placed beneath the pleura, and form a considerable plexus, which surrounds the lungs, collecting their trunks toward the roots, where they terminate in the bronchial glands.

The *deep absorbents*—arise in the parenchyma of the substance of the lungs, accompanying the distribution of the veins, and uniting with the superficial set in the bronchial glands. From thence one or two large trunks proceed along the trachea; others pass to different ganglia, terminating in the thoracic duct by two trunks, and occasionally in the internal jugular, or left subclavian vein separately.

Absorbents of the diaphragm.—These form numerous trunks, which arise from the upper surface of the muscle, and pass to the glands of the anterior mediastinum, before they terminate in the thoracic duct.

Absorbents of the heart.—These are distributed in the course of the coronary arteries, forming two trunks; that with the right coronary artery, terminates in the superior part of the thoracic duct; while that with the left, continues obliquely between the aorta and pulmonary artery, traverses some neighbouring glands, and then enters either the internal jugular vein, or thoracic duct.

Absorbents of the pericardium, and thymus gland—arise in these organs, and collect in trunks, which enter the bronchial glands.

Absorbents of the anterior mediastinum—enter from the abdomen, passing behind the ensiform cartilage, take the course of the internal mammary rami, pass through numerous glands, and then terminate either in the thoracic duct, or right subclavian vein.

Absorbents of the lower extremity—are divided into a superficial and a deep set.

The *superficial*—take an anterior and a posterior course: the anterior set, arise by innumerable minute branches from the upper and fore part of the toes, and dorsum of the foot, where they form a plexus, surrounding the inner malleolus; and then direct themselves upward, along the inner and anterior part of the leg, taking the course of the saphæna major vein, as high as the inner side of the knee.

The *posterior* set—arise from the back part and sole of the foot, by three or four separate vessels, which unite with each other at the outer malleolus, ascend along the tendo Achillis, at the back part of the leg, accompanying the external ramus venosus saphænus, as high as the ham; where they divide, partly to unite with the deep absorbents in the popliteal glands, and partly with the anterior superficial absorbent vessels; and together, take their course upward on the inner side of the thigh, with the ramus venosus saphæna major, to terminate in the superficial inguinal glands.

The *deep-seated absorbent vessels*—are divided into three sets, and take their course with the arterial rami of the leg, receiving corresponding names.

Anterior tibial absorbents—are two in number; one of which arises from the sole of the foot, passing upwards with the ramulus arteriosus communicans of the anterior tibial ramus, upon the dorsum of the foot, and then accompanies that ramus; the other originates upon the outer side of the foot, and at the upper part of the dorsum; it also gains the anterior tibial ramus, and together pass upward, between the tibia and fibula. The first of these branches takes its course upwards, as high as the upper interosseous opening, and then partly terminates in the anterior tibial absorbent gland, and partly continues through the opening, to unite with the other deep absorbent vessels and popliteal glands. The second branch usually penetrates the interosseous ligament about the middle of the leg, and unites with the fibular absorbents.

The *posterior tibial absorbents*—commence with the ultimate ramifications of the posterior tibial ramusculi in the sole of the foot, they pass upward, accompanying the blood-vessels, and enter the popliteal glands.

The *peroneal*, or *fibular absorbents*—arise in a similar manner, from the termination of the peroneal arterial ramusculi, and pass upward, accompanying that blood-vessel, to enter the popliteal glands. All these deep-seated absorbents open, therefore, into the popliteal gland; but afterwards, as vasa deferentia, they form a plexus, from which three or four vessels continue upward, in the course of the popliteal artery, with it pass through the tendinous sheath formed by the adductor magnus and vastus internus, and then continue with the femoral vessels, receiving the deep absorbents of the thigh as they ascend, and terminate by entering the deep inguinal glands. Some few vessels, however, pass upward into the pelvis, under the ligament accompanying the external iliac artery, and terminate in the inferior external iliac absorbent gland.

Superficial absorbents of the lower part of the trunk.—They arise from various sources, and are named respectively.

The *absorbents of the lateral and back parts of the pelvis*—arise from the cellular tissue of the nates, freely communicate with each other, and passing downward upon the anterior and posterior parts of the thigh, unite with the superficial absorbents of the perineum, and inferior extremity; and terminate in the superficial inguinal glands.

The *absorbents of the loins*—form in the loins, from the posterior part and sides of the vertebral column; they descend from the pelvis, and are connected with the superficial inguinal glands.

The *superficial absorbent vessels, from the middle and anterior parts of the abdomen*—form a plexus between the umbilicus and pubes, from which some vessels descend to enter the superficial inguinal glands.

Absorbents also arise from the *perineum*, *scrotum*, and *penis*—which ascend on the inner side of the thigh, uniting frequently with each other, and ultimately ramify in the superficial inguinal glands.

The *deep-seated absorbents of the lower part of the trunk.*—The obturator absorbents arise on the inner side of the thigh, from the termination of the obturator arterial ramus, ascend with that vessel, pass through the obturator ligament into the pelvis, and terminate in the hypogastric glands.

The *absorbents* accompanying the *ischiatic*, *gluteal*, and *internal pudic arterial rami*—correspond so completely with the distribution of those vessels, as to require no separate description. They all terminate in the hypogastric glands.

The *deep absorbents of the testes*—arise from the substance of the epididymes and testes, pass upward in the course of the spermatic cord, and are from eight to ten in number. They continue from the internal ring, with the spermatic arteries, and terminate in the lumbar glands.

Small absorbents, from the *prostate gland, and vesiculæ seminales*—also terminate in the hypogastric glands.

The *absorbents of the uterus*—are large in size during the period of gestation, but at other times, are with difficulty demonstrated. They arise in two sets, one from the surface, and the other from the substance of the organ; the former unite with those from the vagina, and with the latter, terminate partly in the hypogastric, and partly in the lumbar glands.

The *ilio lumbar absorbents*—take their course with the distribution of the corresponding arterial rami, and unite to form larger absorbents, which pass under the psoas muscle, to terminate partly in the inferior lumbar, and partly in the glands which surround the external iliac artery.

Sacral absorbents—arise from the cellular membrane surrounding the rectum, sacral nerves, and pyriformis muscle; some of them pass out of the anterior sacral foramina, and all finally enter into the formation of the hypogastric plexus, surrounding the blood-vessels of the pelvis; and terminate in the inferior lumbar, and hypogastric glands; anastomosing with the lumbar absorbents above, and the external iliac absorbents below.

Epigastric absorbents—arise from the anterior and middle parietes of the abdomen, anastomosing freely with the absorbent vessels from the abdominal muscles, and from trunks which take the course of the ramus epigastricus, and terminate in the external iliac glands.

The *absorbents of the circumflexus ilii*—take their course with their corresponding ramus, and in like manner terminate in the external iliac glands.

The *lumbar absorbents*—arise from the m. quadratus lumborum, and transversus obliquus, and the interior of the vertebral canal. They form numerous trunks, which take the course of the lumbar arteries, and pass between the psoæ, and quadratus lumborum muscles, to terminate in the glands between the transverse processes of the vertebræ. Some pass forward upon the vertebral column, and freely anastomosing, contribute to form the lumbar plexus.

Absorbent Vessels of the Viscera, contained within the Cavity of the Abdomen.

Those belonging to the generative organs, have already been mentioned: the remaining appertain to the urinary organs, and the chylopoetic viscera.

Absorbents of the Urinary Organs.

Absorbent vessels of the bladder.—These arise from the whole surface of the organ, forming a considerable plexus on its parietes, and terminate in the hypogastric glands.

Absorbents of the kidneys, and ureters.—These arise superficially from the external surface of the kidneys, and are directed toward the sinus, where they are forming trunks, which unite with the deep-seated absorbents of the interior of the organ. The two sets then terminate in the lumbar glands. From the ureters, the absorbents take the course of those of the bladder and kidneys, terminating partly in the lumbar glands, and partly in the hypogastric.

Absorbents of the capsulæ renales—arise within the substance of the organ, and passing out with the blood-vessels, anastomose with the absorbents of the kidneys; some on the right side, terminating in the hepatic glands, and on the left, with the splenic, on the corresponding pillar of the diaphragm.

Absorbents of the Chylopoetic Viscera—of the Liver—Stomach and Intestines.

These are usually called lacteals. The greater portion of them arise from the inner surface of the intestines by open mouths in the villi.

They are most abundant in the small intestines; and collecting, form innumerable branches, which enter the mesenteric and meso-colic glands; ultimately terminating in the large trunk, named the thoracic duct.

From the stomach—the absorbents arise in two sets, one superficial, the other deep. Of the first, several arise from the great curvature, and follow the course of the vasa brevia, anastomosing with the absorbents of the spleen: others pass off from the small curvature, to the neighbouring glands, and then continue, some to anastomose with the hepatic glands, near the lobulus spigelii; while others pass to the posterior part of the pancreas, terminating in the thoracic duct.

From the upper and lower surfaces of the stomach, absorbents arise, which pass to the glands of the great curvature, after forming large trunks near the pylorus, and accompanying the cœliac, and superior mesenteric arteries.

Absorbents of the liver—are both superficial, and deep.

The superficial are divided into separate sets—generally four or five in number. One of these from the middle, both of the right and left lobe, forms several large trunks, which ascend between the layers of the suspensory ligament; then pass behind the ensiform cartilage, uniting with the glands there situated; and continue, finally terminating in the thoracic duct, close to the left internal jugular vein.

A second set arise from the right lobe, pass to the right lateral ligament, through the diaphragm, continuing upon its convex surface, until they terminate in the first set.

A third set arise from the left lobe, pass to the left lateral ligament, anastomosing with the absorbents of the stomach, and then terminate in the thoracic duct before it has quitted the abdomen.

The superficial absorbents of the under surface of the liver, form two principal sets, which after uniting, form one set, freely anastomosing with those of the upper surface, and with the deep-seated absorbents: they then unite in trunks, which collect at the porta, and take the course of the hepatic vessels, freely anastomosing with the absorbents of the intestines.

The deep-seated absorbents of the liver, arise in the substance of the gland, and take the course of the minuter ramifications of the blood-vessels, then that of the main trunks, passing out with them at the porta; here they join the absorbents of the inferior surface of the liver, and anastomose with those of the stomach, spleen, pancreas, and mesentery—finally terminating with them, in the thoracic duct.

The absorbents of the omenta, collect with the superficial absorbents of the stomach, and pass to terminate in the glands at its greater curvature.

Absorbents of the spleen—arise from the organ, both on its surface and within its substance, forming trunks, which anastomose with those of the pancreas, and the inferior surface of the liver.

Absorbents of the pancreas—arise from the organ in a similar manner, terminating with the absorbents of the spleen and stomach.

Of the left thoracic duct.—This is the principal terminating trunk of the absorbent system; it commences in the abdomen, upon the body of the third lumbar vertebra, behind the right emulgent artery; and extends to the junction of the left subclavian, with the left internal jugular vein, where it terminates by opening into the posterior part of the left vena innominata, formed by this union. At its termination, it is furnished with valves, to prevent the regurgitation of the chyle from the vein.

The commencement of the thoracic duct is formed of three or four large trunks, which proceed from the absorbents of the lower extremities, and which by their union, produce so great an enlargement, as to have been named the receptaculum chyli—but improperly; for this sac only receives the product of the absorbents, from the lower extremities, and not from the lacteals. The lacteals open into the thoracic duct, above this point, to the right of the second lumbar vertebra, at the united roots of the mesentery and meso-colon, where the duct is narrow, and does not present any appearance of a reservoir; from this point, it ascends from the abdomen into the chest, passing between the right crus of the diaphragm and the aorta, being accompanied by a branch of the vena azygos, which is on its right. It continues on the right side of the aorta, as high as the junction of the fifth and sixth dorsal vertebræ, when it ascends to the left, behind the œsophagus and the arch of the aorta, in front of the longus colli muscle, on the inner side of the left subclavian artery, passing through the upper opening of the chest, as high as the upper part of the seventh cervical vertebra. It then bends downwards and inwards, passing in front of the ramus thyroideus inferior, behind the left internal jugular vein, terminating, as has been before described, at the angle formed by the union of that vein with the left subclavian. In this course, the thoracic duct is not every where of the same size. We have already mentioned the enlargement, at its commencement; after which it contracts, remaining of the same calibre as high as the sixth dorsal vertebra; and while passing behind the arch of the aorta, it is again enlarged. This duct is also variable in its direction, being more or less tortuous in different subjects, as well as in its division into separate branches; which either again unite, or terminate separately on the left side, or one in the left, and the other in the right thoracic duct.

The *right thoracic duct*—is much smaller than the left, receiving only the absorbents of the right side of the upper part of the body. It is seldom more than half an inch in length, and is sometimes wanting; in which case, the absorbent vessels, without forming any duct, terminate separately, either in the right vena innominata, or subclavian vein.

For the practical remarks connected with the absorbent system, *vide* Vol. III. p. 298.

LECTURES ON ANATOMY.

PART VIII.

PHYSIOLOGY OF THE NERVOUS SYSTEM, &c.

LECTURE XXX.

PHYSIOLOGY OF THE NERVOUS SYSTEM.

There is no part of the anatomy and physiology of the human body, which has occupied more attention and diligent investigation, than the nervous system. As the peculiar seat of the intellect, it may be regarded as the most noble part of our frame, and that which appears to be most essentially connected with all the peculiar phenomena of vitality.

Notwithstanding the most learned men, in all ages, have devoted their attention to the nervous system, in order to trace the connection between vital phenomena and material bodies, exhibited in the form of living beings; the subject is still veiled in obscurity, and remains a work of creative wisdom, far above human comprehension.

We are, however, indebted to the labors of modern anatomists for many new and important facts relative to the functions of the brain and nerves; and these may be considered in the order of their developement, their structure, and their general distribution, from which arise the various combinations exhibited in their functions.

The nervous system comprehends the brain, medulla oblongata, medulla spinalis, the cerebral, and the sympathetic nerves.

It was formerly considered, that the brain was the origin of all the nerves; but of late years, the anatomy of the brain has been more particularly investigated in all the stages of its early developement, as well as in relation to the separate influence which individual parts exert over particular functions.

Tiedemann, in pointing out the order of the succession in which the different parts are developed during its fœtal growth, has shewn that there is a remarkable relation between the state of the human brain in its earliest existence, and that of the permanent structures of the lower order of animals. At first, as in them, it is simple, and possesses but few parts, which become more numerous and complicated as the organ proceeds to its full developement; and having these various parts superadded to it, much in the order in which they are found in the progressive scale of animal perfection.

To M. Serres, we are indebted for the light which he has thrown upon the cause, which immediately regulates the growth of the whole nervous system; and this he has found to depend upon the distribution of the arteries. Thus he has observed, that the spinal marrow is produced by the intercostal arteries, which are the first formed blood-vessels in the fœtus; the cerebellum, by the vertebral; and the cerebrum, by the carotid arteries. In these formations, the crura cerebri and tubercula quadrigemina, follow that of the spinal marrow; the cervical region of which is first formed, by the branch of the superior intercostal artery, which enters the vertebral canal. The vertebral artery arrives the last within the cranium, and the cerebellum is therefore the last organ apparent in the formation of the encephalic organ of all classes. Following the arterial order of nervous developement, it is observed that the cerebellum is formed from behind forwards, and the cerebrum, on the contrary, from before backwards; according, in the first instance, with the vertebral artery, which enters at the posterior part, and is directed from behind forwards; and in the latter instance, with the internal carotid artery, which after passing the turns of the cavernous sinus, reaches the anterior part of the brain, and proceeds from before backwards, according to the progress of the formation of the cerebrum.

Hence also the corpus callosum, and anterior part of the fornix, are developed from before backwards, following the progress of the artery; while the posterior part proceeds from behind forwards, with the posterior cerebral artery.

In animals, the developement of the cerebrum and cerebellum, results from the general relation in this union of the vertebral and carotid arteries; and the comparative size of the brain and spinal marrow, appear to depend upon the respective calibre of the arteries which supply these parts with blood. Thus when the spinal arteries are large, the more the spinal marrow is developed; and the more the vertebral and internal carotids increase in size, the greater is the developement of the brain. And it is remarkable, that these structures bear an inverse ratio in their formation, which does not depend upon the preponderance of any portion of the nervous matter in the spinal marrow, but entirely upon that law of life which has regulated the distribution and course of the sanguineous system.

This, as a general principle, is applicable to the nerves in all parts of the organismus.

Thus the great sympathetic nerve diminishes in proportion to the decrease of the sanguineous system.

The size of the middle sacral artery, regulates the dimensions of the caudal prolongation in all animals.

The appearance of the extremities, and their nerves, also depend upon the calibre of their respective arteries: thus the axillary arteries in bimana, and the femoral in bipeds, are those which attain the fullest developement. So in the head, the developement of the face and the brain depend on the volume of the external carotid in the former, and of the internal carotid in the latter. Where the external carotid is large, the face and nerves of sense are extensive.

The ophthalmic artery, however, is always in proportion to the size of the external carotid; from which circumstance, the volume of the eye is still regulated according to the extent of the organs of smell and taste.

Tracing the formation of the nerves themselves, their first appearance is in the form of globules of medullary matter, deposited in the cellular and mucous tissues; these increase, and unite in centres of communication, which form the ganglia: from the ganglia, cords communicating with each other, are next seen taking the course of the larger blood-vessels. This organized state, is first apparent in the semilunar ganglion; and after the ganglia, then the centres of communication of the voluntary nerves appear; and lastly, the nerves destined for the higher powers of voluntary motion and sensation.

According to Dr. Bennett, who adopted the method recommended by Riel, of hardening the embryo in spirits, the brain and spinal marrow are perceptible as early as the seventh week, enclosed in a dura and pia mater—the medulla oblongata being twice as thick as the medulla spinalis.

At this period, he describes the spinal marrow as extending nearly along the whole trunk, and having a fissure at its posterior part, into which the pia mater penetrates; and beneath this fissure, is a cavity or internal canal, extending along the spinal marrow, from the sacrum to the fourth ventricle.

At the superior part of the column, just before its entrance, within the cranium, an enlargement or projection is perceptible, where the fourth ventricle takes its origin; beneath this projection the spinal marrow forms a curve, owing to the flexion of the head upon the chest; and on either side, there is a thin narrow plate inclining from without inwards, forming an arch over the fourth ventricle; these are in contact with, but not united to each other, and afterwards constitute the cerebellum, springing from the restiform bodies. Beyond these appear rudiments of the crura cerebri and tubercula quadrigemina, with the aqueduct of Sylvius between them; more anteriorly lying on the crura cerebri the optic chambers appear, with an interval between them corresponding to the third ventricle. In front of the rounded extremities of the crura cerebri, the corpora striata appear; and lastly, two membranous plates curving inwards and backwards, forming the commencement of the hemispheres of the cerebrum. At this early period, the commissures, pons varolii, corpus callosum, fornix, or its crura, are not perceptible.

The spinal column unites its cavity with the fourth ventricle, at the calamus scriptorius, which at this period may be said to be merely a dilatation of the canal. In fact, the canal forms a broad fissure, which comprehends the third ventricle, aqueductus Sylvii, fourth ventricle, and calamus scriptorius; and is uninterruptedly continuous in the whole length of the spinal column. Towards the end of the second month, the pia mater is observed dipping into the anterior and posterior portion of the column—the latter constituting the canal of this organ. This canal, at first capacious, appears to lessen in proportion to the deposit of medullary matter. The medullary matter is white, until the last two months of utero-gestation, when it becomes soft and reddish, constituting the cortical substance; which circumstance refutes the hypothesis of Doctors Gall and Spurzheim, who consider the medullary matter as formed from the cortical.

A gradual process of developement continues, of which an elaborate account has been given by Dr. Bennett; *vide* Plate 1.; from which it appears, that the following parts succeed each other in their growth. The olivary and pyramidal cords project upwards; the cerebellum forms over the fourth ventricle, by the union of two plates, one from either side, when the canal ceases to be open. The mass which supports the tubercula quadrigemina, arises by two small thin membranes from the olivary tubercles; these, as they enlarge, first cover a large ventricle, which afterwards becomes the fissura Sylvii, from a further deposit of medullary matter. The pyramidal cords taking a direction from below upwards, and from behind forwards, first form two swellings, which are the optic thalami, and corpora striata; and then terminate in two lamina, which bend from before backwards. These are the rudiments of the two hemispheres of the cerebrum: at the second month, these laminæ scarcely cover the corpora striata; at the third month, the optic thalami; at the fourth, the tubercula quadrigemina; and at the sixth and seventh, the cerebellum. In this progress of formation from before backwards, their inversion gives rise to the lateral ventricles. The parietes of the hemispheres are yet smooth; and the appearance of convolutions does not arise until the eighth and ninth months, when the accession of medullary matter is more rapid, and of a darker color, constituting the cortical substance, and lastly the convolutions appear.

Having now considered the order of the fœtal developement of the nervous system, we will next proceed to the intimate structure of the nerves.

A nerve is composed of numerous white filaments, united together in bundles by cellular membrane, and enclosed in a thicker sheath termed the neurilema. It is supposed, that each nervous filament is composed of a tube of pia mater from the brain and spinal marrow; and that it encloses a medullary pulp, capable of concretion by means of nitric acid.

Numerous arteries and veins ramify in the neurilema, and are easily seen in the larger nerves. It is also supposed, that each nervous filament has an origin in the brain, or spinal marrow, and a termination in the part to which it is distributed.

As far as the nerves are visible, they form numerous unions, divisions, and re-unions with each other; from which it is neither possible to trace a single filament, or to ascertain the exact nature of their minutest structures.

They appear to unite and separate, but not to run into one another, in the same manner as the vessels of the sanguineous system.

Four kinds of nerves have been enumerated.

1. Nerves with double roots, the one a conductor of sensibility, the other of motion; these are all the spinal, the sub-occipital, and the trigeminal, or fifth pair.

2. Nerves with a single origin, to the senses and muscles connected with them.

3. The respiratory nerves.

4. The sympathetic, which unite with all the spinal; and probably with all the cerebral nerves.

In the first and second classes, sensation and motion have distinct agents; in the third and fourth, their functions are associated, more or less, by intimate connections.

To the optic nerve, a membranous sheath is furnished directly from the dura mater, and an artery runs in its centre. Nerves in osseous canals also have no membranous sheath, as the vidian branch of the fifth; and they are of greater consistence than nerves enclosed in soft parts.

Having premised these circumstances of the fœtal developement of the nerves, and their structure, we shall be better enabled to trace the mutual dependance, and variety of their functions.

The distribution of the sympathetic nerves, is found to exist in all animals; and as we ascend the scale of perfection exhibited in different orders, we find a gradual succession, first of more numerous ganglia, then of sentient and voluntary nerves, and lastly of an increased bulk of brain which characterizes the mental faculties.

The most limited distribution of nerve, is met with in the form of globules, which are disseminated without apparent order in the substance of the amorphous pulpy mass, of the lowest order of zoophytes. These globules are next met with, confined to the mucous structures only; then organized in an imperfectly developed, but homogeneous ganglion, as in the echinodermata: next, these ganglia communicate by intermediate cords, as in the annelides, &c. The ganglia are then found to lose their homogeneous character; and separate organs appear devoted to the senses, with accessory ganglia, assuming the character of an encephalon, surrounding the œsophagus in the manner of a ring. In these animals, distinct volition is not apparent, but rather a species of instinct, independent of reflection or choice, and presiding simply over the functions of nutrition, and immediate preservation. Next we find the senses and volition more distinct, the appearance of a spinal column, and the encephalic ganglion losing its simple character, and becoming enclosed in a protecting case; at the same time, the spinal marrow appears also enclosed in a protecting apparatus.

In the hymenopteræ, each sensorial nerve has a distinct enlargement at its root in the encephalon; and the division into hemispheres begins to be apparent, forming the prototype of the cerebral masses or hemispheres of all the superior classes.

This order of existence in different animals, has been compared to the progressive developement of the nervous system in man, and the appearance of the growth of the fœtal brain and spinal marrow.

In man, the nerves arise from the brain, medulla oblongata, and the medulla spinalis, and are distributed to the different parts of the body, for the purpose of conveying their vital and sensitive powers—termed also their influence. It was formerly considered, that every nerve conveyed each kind of influence; but we are indebted to Sir Charles Bell, for new views, and a more correct knowledge upon this subject. He first discovered, that certain nerves conveyed the powers of motion; and that others were destined for the purposes of sensation; while a third set conveyed influences, which regulated the functions of respiration—and these he termed respiratory nerves.

It is a wonderful provision of nature, that a bundle of nerves, united by cellular membrane into one cord, should be capable of containing filaments gifted with such opposite powers, as those of motion and sensation; while, upon the minutest anatomical inspection, these filaments do not offer the slightest difference in their appearance.

The only difference which has been traced in nerves, is in their origin, or roots; these roots are embedded in the brain, medulla oblongata, medulla spinalis, or the ganglia; and in these situations, the difference amounts to little more than a slight variation of color. Thus it has been found, that nerves of motion proceed from the anterior, and nerves of sensation from the posterior pillars of the spinal column; while nerves which are distributed to parts concerned in respiration, proceed from the sides of the column. Before the nerves of sensation unite to form a common cord with the nerves of motion, they produce a ganglionic enlargement; and are observed to come out from the column, more abruptly, in more regular filaments, and from a smaller surface than the anterior filaments, or nerves of motion.

From these circumstances Sir Charles Bell has concluded, that every nerve is composed of numerous filaments, each of which has an origin from one of the above-named sources, called its root; and that it is continued, although bound up in cellular membrane and forming a common cord, to the place of its ultimate distribution, independent of the other filaments, and conveys a distinct influence. Hence it is, that when the posterior fasciculi of a spinal nerve are divided, the parts to which it is distributed are found to lose their sensation—their power of motion remaining unaltered; while if the anterior roots are divided, paralysis follows—but sensation still remains.

So far the distribution of nervous influence is simple, and easy to be traced; but the anatomist will find a greater complication when he comes to trace a spinal nerve to its destination; it is impossible for him to unravel a single filament, or even to trace the course of a filament of a motor nerve, from the root to the part that it is destined to move. This complexity arises from the numerous interchanges and inosculations of the branches, forming what is termed a plexus.

These are more numerous, and to a greater extent, in proportion to the number of muscles, and the variety of their functions. Thus the nerves of the face and neck, and the commencement of the upper and lower extremities, are instances of such distributions.

It is not improbable, as suggested by Sir C. Bell, that these numerous interchanges of filaments have much to do with the curious combinations of action among antagonist muscles; as for instance, in the arrangement between extensors and flexors, and contraction and relaxation.

As yet our knowledge does not enable us to form any idea of the means by which the nerves are capable of producing their influence; and hence it is, that various hypotheses have arisen, assigning it to an undulating fluid, to vibration, a nervous atmosphere by which it was capable of extending its influence beyond its termination, to electricity, and to galvanism. All that we know however, is, that there is a connection through the medium of the nerves, between the brain and the muscles, which enables us at will to excite our voluntary muscles to motion; this is therefore a voluntary power, and is lost immediately upon the division of the nerve. This proves that the influence of the will, proceeds from within to without; but with respect to the sentient nerves; from which we derive the faculties of touch, sight, hearing, smelling, and taste; it is their ultimate distributions which receive the impressions, and convey them from without to within, or from the surface to the sensorium. It has been supposed by some physiologists, that as far as refers to the nerves of the senses, it is necessary that the influence should be conveyed to the brain, so that each peculiar sensation may have a large mass of nervous matter for its perception; from which it has been concluded, that the brain is the great centre of intellect, although the integrity of the spinal marrow is essential to the due influence of the brain, and they have a mutual dependance on each other, presiding over the whole organismus.

Having thus generally described the nerves of motion, sensation, and respiration, we will revert to the consideration of the sympathetic system of nerves.

The great distinction between the sympathetic and other nerves, is, that the former preside over involuntary living functions, such as growth, and nutrition; while the latter preside over the voluntary and sentient functions, as motion, and the organs of the senses.

Hence it will readily be seen, why the ganglionic nerves are required only in the lowest animals, possessing simple organic existence; and why the higher animals, endowed with additional powers, are furnished with nerves in proportion to the addition of living functions.

The following table presents some of the leading features, which distinguish the sympathetic from the cerebro-spinal nerves.

SYMPATHETIC NERVES. *Termed also Ganglial, Organic, and Vital Nerves.*	CEREBRAL. *Named also Cerebro-spinal, Voluntary, and Sentient Nerves.*
Found in every order of the animal creation.	Found only in the highest order of the animal creation.
Traced from the earliest developement of the fœtal organization, and never deficient in monstrous births.	Developed subsequently to the ganglionic nerves, and occasionally wanting in monstrous births.
Excited by galvanism with difficulty.	Excited by galvanism readily.
Distributed particularly to the organs of digestion, assimilation, circulation, and secretion; and involuntary muscles — occasionally to voluntary muscles.	Distributed particularly to the organs of the senses, and voluntary muscles—occasionally to involuntary muscles.
The arteries receive ganglial nerves.	Are not distributed to the arteries.
Arise from one or more ganglia, in the interior of the body, as from a centre.	Arise from the brain, and spinal marrow.
Is more independent, the younger and the lower the animal is in the scale of creation.	A mutual dependance of function becomes more intimate, with ganglial nerves, as we ascend the scale of creation.

The sympathetic nerves not only perform all their functions with unerring precision, and carry on the processes of life, independent of either voluntary or sentient nerves; but they are also connected with those nerves, so as to combine with them in many functions, and act independently of them in others. Thus, for instance, growth, nutrition, circulation, and regeneration, are wholly vital functions, and depend upon the ganglionic nerves for their influence. These functions, however, are not only essential to the existence of the animal, independent of each other, but they also have a combined action for higher functional powers; thus, circulation is not only necessary for the existence of the animal, but it is also inseparably connected with the process of respiration; and respiration itself is not only essential to existence, and more or less subservient to circulation, but is further intimately connected with the intellectual faculties of man, as forming the chief instrument of voice and speech:—which functions, being carried on by muscular power, shews the necessity of the union of these nerves with those of motion; and as motion here must also be under the influence of the will, there is a combination of all the nervous influences, through the medium of the sympathetic system.

Thus then we have the sympathetic system of nerves, existing in every animal which has life. Next the encephalic, connected to the ganglionic; becoming more in the character of a brain, as the animal has organs of sense and loco-motion; while the sympathetic, at the same time, is connected by nervous cords, which assumes the appearance of a spinal marrow, as locomotion becomes distinct from the process of digestion and nutrition: but in all, even the more perfect animals, the sympathetic nerves are the first formed, and may be traced in embryos before the spinal marrow or brain are perceived.

In their distribution, and mode of ramification, they differ from the cerebral nerves, and supply separate organs and textures. In their origin, they are traced from the tissues and cellular textures of the earliest formations, and unite with the spinal column—from which latter the brain proceeds; therefore it has been an error to suppose that the nerves are formed from the brain, and spinal column.

A connection so intimate and general takes place in the combinations of the functions of the whole nervous system, that, indeed, they descend by imperceptible degrees, until they are not distinguishable from other living functions, as circulation, respiration, &c.

This connection takes place, principally, in the medulla oblongata; and as the spinal column consists of different component pillars or cords, so is its termination separate—the posterior pillars passing to the cerebellum, the anterior to the cerebrum; and by some physiologists it has been supposed, that the corpora quadrigemina form a centre of influence to the ganglionic nerves; by others, the ganglionic have been considered as a mere collection of branches, formed by filaments reciprocally given off and received from all the rest of the system.

Physiologists have pursued the research, in order to discover the particular connection and influence of the nervous system over the muscular, and other vital powers.

Several curious facts have been the result; which prove still further, how intimately the whole nervous system is connected. Thus it has been found, that although particular nerves are distributed from the spinal column to the various muscles and skin, imparting sentient and voluntary influences; yet there are certain powers connected with the brain, which preside over the direction of these muscular actions.

This has led to a series of experiments, which consisted of slicing off portions of the brain in a living animal, and marking the effects produced. Some of these are extremely curious.

In mammalia—the hemispheres of the cerebrum may be cut away, down to the corpora striata, without exciting any sensible effect of pain; but the senses of hearing and sight are lost; and the will no longer manifests itself by voluntary acts. The animal appears to act, and to perform regular movements, as if the memory was lost, with its seat the hemispheres.

Thus the integrity of the cerebrum appears to be necessary, to the senses of hearing, seeing, memory and volition.

Upon removing the cerebellum, the locomotive powers are deranged; and its integrity appears to be necessary for the powers and regularity of locomotion.

Majendie states these effects in the following order.

The removal of the hemisphere of the cerebrum in birds, leaving the optic tubercles untouched, produces a lethargy; but, in numerous instances, they will run, jump, and swim—sight only being extinct.

In reptiles and fishes, no effect is produced.

On removing the corpora striata in mammalia, the animal darts forward with great rapidity; if it stops, it preserves its attitudes of escape.

On removing the cerebellum, the power of motion ceases, in proportion to the quantity removed, until it stops altogether. On injuring this part, the animal attempts to move backwards only. Hence it appears that there are two powers in equilibrium—one inducing forward, the other receding motions; and when either of these are destroyed, the other predominates with an irresistible propensity—uninfluenced by the will.

There also appears to be similar powers presiding over the lateral and rotatory motions of the body.

If one of the crura be divided, the animal immediately begins to roll about, as if irresistibly impelled, to the side on which the crus is divided; so rapid, as to make sometimes sixty revolutions in a minute—the same occurs to each crus; and the motions are more rapid the nearer the division is made to the origin of the crura, or near to the pons Varolii.

On tracing these effects in an opposite direction, it was found, that there was a point beyond which irritability of muscular powers ceased—this point is the corpora quadrigemina; from whence it has been concluded, that the cerebrum and cerebellum are not irritable, and wounds of these parts do not excite or cause convulsions; but at the commencement of the tubercula quadrigemina, the medulla oblongata originates, and with it, sensation.

In a voluntary muscular action, three causes appear to operate—for the will only excites and determines the movement, but is not the efficient cause; the spinal marrow and nerves are the immediate cause.

1st.—Volition of movement, residing in the cerebral hemispheres.

2nd.—Regulation of movement, residing in the cerebellum.

3rd.—Excitation of the above movements, in the spinal marrow and nerves.

The one excites, the next regulates, and the other receives.

Thus sight may be destroyed in two ways—by the removal of the tubercula quadrigemina, causing the loss of the sense of sight; or the removal of the cerebral lobes, causing the loss of the sensation of sight.

There is, therefore, distinct organs for the senses, for the sensations, and for the movements.

From the above considerations, we are naturally led to the intricate subject of the mind, as the result of the complete and healthy performance of all the nervous and vital functions of the body.

This, like many of the vital phenomena, may be said to be known only by its effects; its cause has baffled the researches of the most learned in all ages, and remains to this hour unknown.

I must, however, advert to the researches of Gall and Spurzheim, which appear to have arisen in the observation, that the volume of the hemispheres is in proportion to the degree of intellect possessed by the animal.

The length to which they have carried their observations, however, in assigning particular convolutions or portions of the surface of the brain to every passion and propensity, extending even to the predilection for particular arts and sciences, and of arranging them as so many distinct organs, requires far greater proofs for their establishment than we at present possess; for it may be observed, that we so frequently meet with the external table of the skull having elevations without corresponding depressions of the internal table; and again, enlargements of the convolutions, producing depressions of the internal table, yet no corresponding elevation of the external table—that inferences so general and decided as those assumed by Gall and Spurzheim, appear to be too fallacious to be relied upon. Great credit is however due to them, in an anatomical point of view, for the method in which they traced the fibres of the medullary matter of the brain; and which has certainly led to important facts, relative to its intimate structure.

I shall not here enter into a detailed account of the mode by which Gall and Spurzheim trace the columns of the spinal marrow into the substance of the brain, to enter into the composition of its several parts; but in the descriptive anatomy of these parts, I shall speak of their connection with the spinal marrow.

Dr. Foville, of Rouen, has also added some important facts to our knowledge, respecting the anatomy of the brain, and has supported his doctrines by numerous pathological facts.

In a demonstration which he gave at Guy's Hospital, in 1830, he stated, that he considered the corpus callosum was not produced by the transverse fibres of the hemispheres running across from one side to the other, forming a complete commissure, as stated by Gall and Spurzheim; but that it is produced by the corpora pyramidalia, after they have entered the corpora striata, rising up and forming a union in the middle line above the striated bodies and thalami—thus forming the corpus callosum; while another portion passing downwards and inwards, and then upwards to the middle line of the corpus callosum, where being only slightly separated from a similar structure or plane of medullary matter in the opposite side, produces the septum lucidum and fifth ventricle; while a third portion, passing laterally, goes to the hemispheres of the brain. To explain this better, it will be necessary to trace Dr. Foville's view from the spinal marrow; which is composed of two symmetrical portions, each formed of an anterior, posterior, and middle column.

The portion of the spinal marrow named the medulla oblongata, forms several enlargements; one part of which is prolonged into the cerebrum, another into the corpora quadrigemina, and a third into the cerebellum.

Thus the corpora restiformia, are traced to the cerebellum; the corpora olivaria, to the tubercula quadrigemina; and the corpora pyramidalia, to the cerebrum: the anterior fibres of the corpora pyramidalia decussating.

In the cerebellum, the corpus restiforme unites with the processus ad testes and the tuber annulare, forming a mass, which expands into a plane extending from within outwards, to the cineritious matter, where it lines all the folds formed in the cineritious exterior.

One part of this plane passes backwards, from without inwards; and with its fellow from the opposite side, forms a commissure in the processus vermiformis, analogous to the corpus callosum, or commissure of the cerebrum.

The corpora olivaria, form two bundles of fibres, which may be traced to the tubercula quadrigemina.

The corpora pyramidalia, each forms two bundles of fibres —the anterior of which only decussate; the posterior continue to the superior transverse fibres of the tuber annulare, and rest upon it, while their upper surface forms the floor of the fourth ventricle. These two bundles are separated from each other by the corpus niger, and proceed nearly parallel till they diverge in the corpora striata, and thalami nervorum opticorum; and form a large plane, directed obliquely outwards and upwards, of nearly a triangular figure, bounded by two straight and one curved line. The two sides of the expanded crus, or plane, form the two straight lines; the corpus striatum and thalamus, the curved line to the outer side of the ventricle—to which the expanded fibres diverge as to a circumference.

From this circumference three separate planes proceed, forming three layers, one above the other, at their origin.

The first or superior of these planes, rises on the outer side of the corpus striatum and thalamus, at first nearly vertically; it forms a slight convexity outwards, and then bending inwards horizontally towards the mesian line, unites with its fellow to form the corpus callosum.

The corpus callosum, therefore, proceeds from the crura cerebri, and has nothing to do with the hemispheres; they form a true commissure to the crura cerebri; but Dr. Foville observes, that he has not ascertained whether the fibres of the two sides cross or anastomose with each other.

The second plane or central one, immediately beneath the former, at first ascends parallel with, and applied to that of the corpus callosum; then it separates, and is reflected inwards, nearly in a vertical direction, until it reaches the cineritious substance of the most elevated part of the hemispheres, along its whole length, when the convex external and flat internal parts meet each other. It lines the grey matter, following all its folds in the form of a white layer, of which the fibrous structure is not so evident as that of the plane itself. The fibres of this layer, therefore, diverge towards the circumference, and converge towards the expansion of the crura, of which they are a continuation.

The third plane, is of less extent than the two preceding; it proceeds from the same line with them, and descends to the outer side of the inferior half of the grey substance of the corpus striatum, invests it below, and advancing inwards, meets the corresponding plane from the opposite side, and then ascends, forming the septum lucidum of the ventricles. Some of the fibres of this plane do not pass directly to the septum lucidum, but pass backward, reach the extremity of the cornu ammmonis, and becoming continuous with the corpus fimbriatum, pass into the fornix, and form a second communication with the septum lucidum. Other fibres pass and form an expansion, especially destined for the temporal lobe of the hemispheres.

From these interesting anatomical points, Dr. Foville considers that the cerebellum is the central organ of sensation; the tubercula quadrigemina, of the influence of organic life; and the cerebrum, of motion; and that the mind resides more particularly in the cineritious matter, as a percipient centre: and considers the medullary part of the brain as the nerves, conveying the influence of the will from the sensorium to the exterior of the body, or parts of motion, and conveying to the sensorium the impressions of the exterior senses.

As physician to a large lunatic asylum at Rouen, Dr. Foville had an opportunity of examining frequently the brains of those who were the subjects of different kinds of madness; from which he was led to divide mental derangements into three classes. Those depending on false impressions, in which the medullary portions were found diseased, and hence their powers of conducting proper impressions deranged; those depending on a troubled state of mind itself, in which the cineritious portions were diseased; and in those depending upon paralysis of the insane, he found the cellular membrane connecting the fibres of the medullary part of the brain so altered by inflammation, that its structure could not be unravelled.

When extravasation of blood has occurred into the brain, Dr. Foville has seen paralysis recede as the blood became absorbed, and recur at intervals if the disease tended to farther extravasation, either of blood or serum. He also brought forward several cases, to prove that the motions of the lower extremities depended on the integrity of the thalami, and of the upper extremities on the integrity of the corpora striata; and one case in particular, where a surgeon, on putting on a ligature around the axillary artery, included some or one of the axillary nerves; the result of which was an abscess in the thalamus, and consequent death. In diseases extending from the corpora striata to the thalami, the lower extremities are first affected, and then the upper.

In the annexed diagrams, the developement of the structure of the brain, according to Dr. Foville, will be seen, and should be compared with the dissections and plates made by Gall and Spurzheim; the former may perhaps be considered preferable, inasmuch, as it is supported by pathological facts of so much importance to medical science.

LECTURE XXXI.

DESCRIPTIVE ANATOMY OF THE NERVOUS SYSTEM.

The Membranes of the Brain.

THE brain and spinal marrow, are invested with three membranes—the dura mater, tunica arachnoidea, and pia mater.

The *dura mater*—is the external of the three envelopes; it is composed of two laminæ, the external of which lines the inner surface of the bones of the skull, and its vessels unite with the external pericranium—this may be termed its periosteal portion; while the inner is destined to support and insulate different parts of the brain, and may be considered as its cerebral lamina.

The *periosteal, or outer lamina*—belongs to the fibrous tissue; it is in close apposition with the bones of the skull, to which it is firmly united, more particularly in the course of the sutures, so as to render it difficult to remove the calvarium. When this has been done, the dura mater presents an uneven floccular appearance, from the filaments and blood-vessels being torn through, which had connected this membrane to the bones.

At the base of the skull, the periosteal portion of the dura mater is much more firmly united than on the vertex, in consequence of the numerous inequalities of the surface; and also from its sending prolongations through the various foramina, for the purpose of defending the nerves which they transmit. It is likewise continued along the whole length of the spinal column, to give a covering to the spinal marrow. Some anatomists have given a minute description of the attachments of the periosteal surface of the dura mater, over each bone entering into the formation of the skull, pointing out the situations in which it is more or less firmly attached; but as these attachments invariably depend upon the irregularity of the surface, the foramina, or the junction of the bones, osteology points out sufficiently where they must necessarily occur.

Upon the external surface of the dura mater, in the course of the sagittal suture, a number of small projections may be observed, which usually produce corresponding depressions upon the parietal bones—these are termed the glandulæ Pacchioniæ; their use is entirely unknown. The organization of the periosteal surface of the dura mater, is similar to the rest of the fibrous system, being composed of numerous fibres of a metallic lustre, running in parallel lines, and connected with each other by cross fibres.

The *internal or cerebral lamina* of the dura mater—presents a smooth, moist, polished appearance, which it acquires from the secreting surface of the tunica arachnoides. Although described distinct from the external coat, it is with great difficulty separated, excepting in the course of the sinuses, and the commencement of its different septa and processes.

The processes formed by the internal layer of the dura mater, are the falx major, vel falx cerebri,—falx minor, vel falx cerebelli,—and the tentorium.

The *falx major, vel falx cerebri*—is the largest of these septa, and reaches from the foramen cœcum, to the inner protuberance of the occipital bone. It is in the form of a sickle or scythe, being pointed anteriorly, and gradually becoming broader as it passes backwards between the hemispheres, until it reaches and terminates on the tentorium. This process presents a superior convex edge, corresponding, first, to a groove on the frontal bone, then to a groove common to the parietal bones, and lastly, to the vertical groove of the occipital bone. It is in this course hollow, from the separation of the internal from the external lamina of the dura mater, and lodges the superior longitudinal sinus. Its inferior edge is free and thin, and presents a concavity, which faces towards the corpus callosum, and contains the inferior longitudinal sinus. Anteriorly, the falx major is connected with the crysta galli of the ethmoid bone: and posteriorly, with the tentorium, where it contains the torcular Herophili.

The use of the falx major, is, to support either hemisphere in the lateral positions of the head, and to prevent their injuring each other upon concussion, as well as to contain the longitudinal sinus.

The *tentorium cerebelli, vel septum transversum*—separates the cerebrum from the cerebellum; proceeding from the lateral grooves of the os occipitis, it continues along the angles of the temporal, as far as the clinoid processes of the sphenoid bone; thus dividing the cavity of the cranium into two compartments—the upper for the cerebrum, and the lower for the cerebellum. It allows, however, of the union of these two great portions of the brain, by a semilunar aperture, which corresponds with the pons Varolii. The tentorium presents an upper surface, which is convex, and supports the posterior lobes of the cerebrum; and an inferior concave surface, which lodges the upper part of the cerebellum. Its convexity, or larger circumference, is connected with the grooves of the depressions which lodge the lateral and petrosal sinuses; its smaller circumference, or concavity, is opposed to the superior vermiform process of the cerebellum, the crura cerebri, and the pons Varolii. The tentorium is held in its situation by the falx major, and minor; and both its surfaces are covered by the tunica arachnoidea.

The *falx minor, vel falx cerebelli*—cannot be seen until the cerebrum is removed, and the tentorium cut away from its attachments to the sphenoid and temporal bones; when it will be exposed proceeding by a broad base from the under surface of the tentorium, to the foramen magnum. Superiorly, where it is attached to the tentorium, it assists in forming the torcular Herophili. Posteriorly, its convexity is connected with a groove in the vertical spine of the occipital bone, and lodges the occipital sinuses. Its concave anterior edge, separates the lobes of the cerebellum. Its uses are to support the cerebellum, to maintain the tentorium, and to form some of the sinuses of the brain.

There are yet two small processes of the dura mater, which pass from the alæ minores of the sphenoid bone into the fissura Sylvii, and serve to enlarge the surface for the support of the anterior lobes of the cerebrum—these have been termed the *sphenoidal folds.*

The vascular system of the brain and spinal cord, presents several peculiarities. The arteries and veins do not accompany each other, and the arterial ramifications run most minutely on the pia mater, before they enter the brain; while the veins which lie in the sulci, between the cerebral convolutions, pass into the sinuses of the dura mater; which constitute the venous circulation of the brain, and correspond to the veins in the rest of the body. These sinuses, produced by the processes of the dura mater, are very irregular in their form. They are lined by the inner membrane of the jugular veins.

In the description of the sinuses, I shall deviate from the usual course, and commence with the ophthalmic veins, which terminate in the cavernous sinuses.

The blood which is conveyed to the eyes, and their appendages, by the arterial ophthalmic ramuli, through the foramina optica, is not returned by any accompanying veins, but by the ophthalmic veins, which pass backwards, through the foramina lacera orbitalia superiora, into the *cavernous sinuses.* They are placed, one on each side of the sella turcica, in grooves on the sides of the body of the sphenoid bone; the dura mater, in this situation, has its laminæ separated by numerous septa, which form it into several compartments,—having not only to receive the refluent blood from the eye, but also to form canals for the third, fourth, first division of the fifth, sixth pairs of nerves, and the internal carotid ramus.

The cavernous sinuses are connected with each other by two smaller sinuses, which cross the upper part of the body of the sphenoid bone, surrounding the pituitary gland—the refluent blood of which they receive. These sinuses have been termed the *circular sinuses.* Posteriorly, the cavernous sinuses terminate in the superior and inferior petrosal sinuses.

The *inferior petrosal sinuses*—take their course downwards and backwards, in a groove common to the cuneiform process of the occipital, and petrous portions of the temporal bones, to terminate in the commencement of the jugular veins, by passing through the foramina lacera basis cranii. The inferior petrosal sinuses are connected with each other by one or two small sinuses, which cross the cuneiform process of the occipital bone, and are termed the *anterior occipital sinuses.*

The *superior petrosal sinuses*—take their course along a groove upon the acute superior edge of each temporal bone, and terminate in the lateral sinuses, at the junction of the temporal with the occipital fossa—in which the lateral sinuses are placed.

The *superior longitudinal sinus*—is for the purpose of conveying the blood from the hemispheres of the cerebrum; it commences at the crysta galli of the ethmoid bone, and occupies the upper convex edge of the falx major. The opening of this sinus is of a triangular form, and is larger posteriorly, than anteriorly. The upper part or base of the sinus, is formed by the periosteal portion of the dura mater; while the sides and apex, are produced by its inner or cerebral layer; its interior is smooth, and polished in its whole extent, being lined with the internal coat of of the veins.

Glandulæ Pacchioniæ—are found on the outer side of the superior longitudinal sinus; there are also some few to be found within the sinus, as well as some little tendinous bands, which cross its cavity, and are termed the *chordæ Willisii.* Upon the sides of this sinus numerous openings, furnished with valves, may be observed, of the several cerebral veins, which pour their blood into it. These openings are directed from behind to before; consequently, in a different direction to the course of the blood. This arrangement, as well as the existence of the chordæ Willisii, and glandulæ Pacchioniæ, have all been considered as being for the purpose of retarding the flow of blood through the sinus. The superior longitudinal sinus, where it terminates upon the tentorium, either opens immediately into the right lateral sinus, or into a cavity of an irregular form, which is placed at the union of the three great processes of the dura mater. This cavity is termed—

The *torcular Herophili.*—It is of an irregular form, and lined, like the rest of the sinuses, by the internal membrane of the veins. It presents, usually, the following openings—above, from the superior longitudinal sinus; below, from the two occipital sinuses; in front, from the inferior longitudinal sinus; and on either side, from the lateral sinus. Thus the blood of all the sinuses, is pressed through this opening; from which circumstance, the name of torcular Herophili has been given to it.

The *inferior longitudinal sinus*—is much smaller than the superior, and returns little more than the blood of the falx major. It occupies the lower concave surface of the falx major, and takes its course backwards; and when it reaches the junction of the falx major with the tentorium, it loses the name of the inferior longitudinal sinus, and is termed—

The *straight sinus.*—This extends from the termination of the inferior longitudinal, backwards, to the torcular Herophili, occupying the whole space of the attachment of the falx major with the tentorium. It is triangular, and smaller anteriorly than posteriorly. It receives the blood from the inferior longitudinal sinus, as well as from the lateral ventricles, by the venæ Galeni, which are furnished with valves, as they open into the sinus.

There is also some small quantity of blood returned from the upper part of the cerebellum, into the straight sinus.

The *posterior occipital sinuses*—are two of small size, surrounding the foramen magnum; they commence near the foramina lacera basis cranii, frequently communicating with the lateral sinuses, and then pass backward on either side of the foramen magnum until they reach the spine of the occiput, where they become situated within the falx cerebelli, ascending between its layers and terminating in the lower part of the torcular Herophili. These sinuses convey the blood from the under surface of the cerebellum, and from the falx cerebelli.

The *lateral sinuses.*—These conduct the blood which has been conveyed to the torcular Herophili by the sinuses already described, to the jugular veins, through the foramina lacera basis cranii, terminating in them at the jugular fossæ. They commence from the sides of the torcular Herophili, opposite to the internal protuberance of the occipital bone, take their course outward in the transverse grooves of that bone, pass over the posterior and inferior angle of the parietal bone, and then gain the groove of the temporal bone; and just before they reach the foramina lacera, receive the superior petrosal sinuses, as before mentioned. In this course, they also receive some small veins from the cerebellum, posterior lobes of the cerebrum, tentorium, and while on the temporal bones, from the internal ear.

There are no chordæ Willisii found in their interior, as in the other sinuses.

Thus we may regard the lateral sinuses as the main trunk of the venous circulation of the interior of the skull.

Tunica arachnoidea—is a serous membrane, placed between the dura and pia mater, and like all other serous membranes, forms a closed sac. It presents an exterior rough surface, connected to the dura and pia mater, and an internal smooth secreting surface, constantly moistened by an halitus, for the purpose of preventing the injurious effects of friction upon motion. It covers the whole surface of the brain; not, however, passing down with the pia mater, between the convolutions. Hence to demonstrate this membrane, it is only necessary to introduce a blow-pipe under the tunica arachnoides, in one of the fissures; and, by inflation, the air will pass between, and exhibit their separation.

This membrane is reflected from the brain to the dura mater, which it lines throughout, excepting at the sella tursica; in which situation, the pituitary gland is placed between the two membranes. It is also reflected from the brain to the dura mater, by processes surrounding the several veins which pass to enter the sinuses; this may be seen more particularly at the superior part of the brain, around the veins entering the longitudinal sinus. At the inferior surface of the brain and medulla oblongata, each nerve is surrounded by a portion of tunica arachnoides, which is reflected upon the dura mater, where the nerve penetrates it; so that the arachnoid membrane forms a *cul de sac*, which closes the opening at the exit of each nerve.

The tunica arachnoides, passes into the ventricles of the brain, giving to them a serous lining; it enters through the foramen of Bichat, which may be seen by pressing the posterior lobes of the brain gently asunder, so as to expose the venæ Galeni at the anterior edge of the tentorium, where they are entering the straight sinus; and immediately underneath these veins, the small round hole will be found, leading to the lateral ventricles, above the pineal gland. This foramen is lined by the tunica arachnoides, which passes forwards into the lateral ventricles, surrounding all the parts contained within them, and proceeding from the lateral, into the third and fourth ventricles. Indeed, to describe each reflection of this serous membrane, would be to enumerate all the irregularities both upon the exterior and interior of the brain; it need only be observed, however, that like the other splanchnic serous membranes, it presents a visceral and parietal portion, shutting out every viscus which it lines from its internal secreting surface.

The *pia mater*—the third tunic of the brain, might with propriety be termed the tunica vasculosa cerebri, as all the arteries, before they supply the substance of the brain, ramify most minutely upon this membrane. For this purpose, it dips between the convolutions, and into the cavities of the lateral ventricles, where it is named the plexus choroides. It is in fact, merely a cellular tissue connecting the visceral portion of the tunica arachnoides with the brain, but is separated from the tunic, as it dips down into the sulci between the convolutions. The pia mater enters the descending cornu of the lateral ventricle from the fissura Sylvii, where indeed the plexus choroides commences; and at the foramen of Monro, just at the interior part of the thalami nervorum opticorum, it unites with its fellow from the opposite side. Underneath the fornix, above the tubercula quadrigemina and pons varolii, the pia mater may be seen, passing across from one plexus choroides to the other, closing the fissure between the two thalami, forming what is called the velum inter-positum. This portion is covered by the tunica arachnoidea. Where the pia mater is prolonged into the fourth ventricle, upon the upper surface of the medulla oblongata, it is also invested by a reflection of the tunica arachnoides.

The pia mater, as well as the tunica arachnoidea and dura mater, are all continued upon the spinal marrow; and will be particularly described, when speaking of that portion of the nervous system.

The use of the pia mater, seems to be as a medium of connection between the different parts of the brain, as the cellular membrane is to the other parts of the body; and also to present an extensive surface for the minute division and peculiar arrangement of the blood-vessels of the brain.

Practical Remarks.

The dura mater, in common with the other structures of the body, is liable to inflammation, either from wounds or other injuries, as well as from the extended effects of inflammation, proceeding from the exterior coverings of the skull. Indeed, this latter cause may be considered as the most common, in consequence of the frequent inosculation of the blood-vessels of the pericranium with those of the dura mater, as well as the greater exposure of the former to external injuries.

When inflammation attacks the dura mater, its effects are so violent and sudden, that it rarely proceeds beyond the adhesive stage, for the patient generally sinks before the formation of pus; and upon examination after death, a layer of adhesive matter will be found connecting the dura mater and the tunica arachnoides, sometimes only confined to one spot, while at others it will be more extensive, or even general.

When suppuration does take place, the matter is usually found between the dura mater and the skull; and this is generally the effect of external injury—producing, at first, inflammation of the pericranium, and its separation from the bones of the skull; and subsequently, the separation of the dura mater from the interior of the skull, and the formation of abscess. In such cases, the matter presses on the brain, and will necessarily destroy life, unless means are adopted by which the matter may be successfully evacuated.

The symptoms come on insidiously, and frequently after injury to the skull, when the patient appears to have arrived at a convalescent state, he suddenly becomes comatose, from the formation of matter between the dura mater and skull.

This state of insensibility, however, is usually preceded by a rigor; under these circumstances, therefore, the head should be shaved, the scalp examined with the greatest precaution, and if any puffiness can be discovered, an incision is to be immediately made down to the bone; which if it be found denuded, dry, and of a white color, denoting its death, that part may be removed with a trephine—indicating the almost invariable situation of the matter.

Pus sometimes forms in the longitudinal sinus, or makes its way into it from the extension of inflammation; in these cases, there is usually matter found in other situations, leading to a fatal termination.

Serum also forms between the dura mater and tunica arachnoides, or more properly, within the secreting cavity of the latter tunic; this occurs, as in the other splanchnic serous membranes, either from an increased action of its blood-vessels, or diminished power of the absorbents. The disease is named hydrocephalus externus, and is of rare occurrence. If the bones of the head be completely ossified, the quantity of fluid collected, is never more than three or four ounces—producing, during its formation, violent symptoms; but if it occurs at such an early period of life that the bones of the head are not yet completely ossified, the quantity of fluid accumulated may amount to fourteen or fifteen ounces. This disease frequently leads to the formation of spina bifida, which it effects by its pressure preventing the bones of the spine consolidating; so that a tumor is produced in the course of the spinous processes of the vertebræ—the fluids pushing the membranes of the spinal marrow before it.

This disease Sir Astley Cooper made the subject of his particular investigation, and he first attempted to cure it by pressure; but he soon found that this treatment tended to produce either paralysis of the lower extremities, and even sometimes to lead to symptoms of apoplexy. He then tried the effects of puncturing the tumor with a small needle, and evacuating its contents—repeating the operation upon the re-appearance of the tumor, at the same time using gentle pressure. This method has been attended with success, in three or four instances; but with every precaution, puncturing the membranes sometimes leads to incurable ulcerations, purulent discharge, and a subsequent fatal result.

The dura mater, like other fibrous structures, is liable to fungoid tumors, which frequently produce absorption of the animal parts of the bone, giving it a porous appearance; the earthy parts are next absorbed, when a fungoid tumor makes its appearance externally.

The dura mater is also liable to earthy depositions, several specimens of which we have in the museum at Guy's Hospital. Such depositions lead either to epilepsy, inordinate action of the heart, disordered action of the stomach and chylopoetic viscera, accompanied with a tendency to violent irritation of mind, and leading sometimes even to insanity.

It is remarkable, that the train of symptoms arising from this cause resemble very much the symptoms attending earthy depositions upon the coronary arteries, or on the valves of the larger arteries arising from the heart. Indeed, the symptoms are so similar, as frequently to cause considerable difficulty in forming a just diagnosis.

The tunica arachnoides, very rarely presents any morbid appearances, although the deposition of adhesive matter, which is so frequently attributed to the dura mater, is likely to be the result of inflammation of this serous membrane.

The pia mater, is more subject to inflammation than the dura mater; in which state, it frequently exhibits a very high degree of vascularity —an appearance almost invariable in those persons who die of phrenitis. When suppuration follows, the matter is found between the brain and its membranes; and this is most frequently produced by ill-treated diseases of the ear. I have myself seen, and could quote numerous instances, in which inflammation of the pia mater suddenly came on from the application of highly stimulating injections in diseases of the ear.

The pia mater, is comparatively rarely the seat of any other disease than inflammation. Sir Astley Cooper, however, has recorded a case, which occurred to a patient of his in Guy's Hospital, who died of chorea, in whom earthy matter was found deposited upon the pia mater.

LECTURE XXXII.

DESCRIPTIVE ANATOMY OF THE BRAIN.

The brain, or encaphalon, is placed within the cranium, and is composed of a soft pulpy mass, enclosed within the membranes, which have been described.

This pulpy substance was formerly considered to be composed of a homogenious mass of medullary matter; but experiments and physiological observations prove, that it is no longer to be so considered; but that its different parts are destined to convey different influences, and to receive impressions peculiar to themselves; and that the organ, therefore, is to be viewed as complex in its structure, and various in its functions.

The brain is divided by a mezian line, passing in a direction from before to behind, into two equal parts; but this separation is not occurring in every part of the brain; for in several situations, the parts corresponding on either side, are brought into communication in the middle line by processes of brain, termed commissures. There are also other fissures besides these longitudinal ones, which separate portions of the brain in a transverse direction; these are more particularly to be observed on the base of the brain, producing such distinct separations, as to have led to the division of the brain into four distinct parts: the cerebrum, cerebellum, pons varolii, and medulla oblongata. These parts, together with the medulla spinalis, we shall first describe generally, pointing out the several appearances to be observed upon their exterior, and then proceed to the more important structures which characterize their interior.

Of the Exterior of the Cerebrum.

The *cerebrum*—forms the largest portion of the brain, and occupies the whole of the upper part, and the anterior and middle portions of the base of the cavity of the cranium, leaving only the lower and posterior part of the base for the cerebellum, from which it is separated by the tentorium. The cerebrum occupies the space included above a plane, bounded by the upper edge of the annular protuberance of the pons varolii before, and by the lower edge of the inferior corpora quadrigemina behind; and all below this plane is occupied by the cerebellum.

The cerebrum weighs, according to the late Dr. Gordon of Edinburgh, from thirty-five to forty-five ounces avoirdupois. Its length is from six inches and a quarter to six inches and a half: its breadth from five inches and a quarter to five inches and a half: and its depth from two inches and three quarters to three inches. As to its form, it varies in different subjects; still these varieties are but slight: it is somewhat ovoid, convex above, somewhat compressed laterally, and flattened below. Its posterior extremities are larger than the anterior.

Upon the upper surface of the cerebrum, a deep longitudinal fissure separates it into two halves, which are denominated the two hemispheres. This longitudinal fissure is not of the same depth in its whole extent; being one inch and three quarters in front, where it extends completely to the basis of the skull; behind, it extends to the tentorium, separating the posterior lobes of the brain, and is from two inches and a half to two inches and three quarters deep; while in the middle it does not extend to the base of the brain, but reaches no farther than the corpus callosum, and is not more than one inch in depth. This fissure is occupied by the falx major.

Each hemisphere forms the fourth of a solid ovoid: the divisions of which are marked by the longitudinal fissure above, and by the plane already mentioned as separating the cerebrum from the cerebellum, below. The only deviation from this fourth of an ovoid figure, is the projection of the under surface of the middle lobe of the cerebrum.

The surface of each hemisphere is marked by numerous serpentine ridges, with corresponding depressions between them: the former being termed convolutions or gyri; the latter, fossæ or sulci. The convolutions pass in various directions, present different forms and sizes, and are from a quarter to one inch broad. They are, in general, of comparative small size in young children: and it is to be observed, that the convolutions are not symmetrical in any two corresponding points of the two hemispheres. The fossæ or sulci are as variable as the convolutions in form, size, numbers, and direction. They vary from each other with respect to their depth; some being superficial, while others extend an inch deep. All of them are lined by prolongations of the pia mater. On separating these sulci, in some of them it will be observed, that secondary convolutions pass into them, so as to produce considerable irregularities in their form.

It has been observed by Bichat, that the irregularities of the surface of the hemispheres, have no corresponding irregularities upon the under surface of the bones of the skull.

The lower surface of the cerebrum, which is composed of the bases of the two hemispheres, has been divided by anatomists into distinct regions, termed the lobes—which are three in number on either side, and are denominated the anterior, middle, and posterior lobes. The surfaces of these lobes are marked by convolutions and sulci, similar in their general appearance to those on the upper surface; but they are smaller, less serpentine, and more shallow.

The anterior lobe of each hemisphere is the largest of the three, and extends backwards the distance of one half the hemisphere. It is somewhat flattened generally, but yet presents a slight depression, which is concave from side to side, to correspond with the convexity of the orbitar plates of the frontal bone, upon which it rests. The inner edge of each anterior lobe is formed of a projection produced by the inner boundary of a fossa, which lodges the olfactory nerve; and between the ridges of the two sides, the great longitudinal fissure of the cerebrum is placed, and the falx major commences.

The middle lobe of the brain forms a very considerable prominence beneath the plane of the anterior lobe, and fills the deep fossæ in the middle region of the basis of the skull. It is convex on its outer and lower surface, and is separated from the anterior lobe by a deep fissure, termed the fissura Sylvii; which corresponds to the posterior edge of the ala minor of the sphenoid bone, and lodges the ramulus arteriosus medius cerebri. This fissure is various in its length in different subjects, and usually not wider than the sulci between the convolutions, excepting just at its commencement anteriorly. This fissure extends backwards and inwards, nearly at a right angle, into another fissure, which runs longitudinally—bounded on the outer side by the middle lobe of the brain, and internally by the optic nerves and crura cerebri. It is this fissure which admits of the passage of the pia mater into the lateral ventricles, but the opening is closed by the tunica arachnoides.

The posterior lobes are not so well defined as the middle, and anterior, the middle lobe being insensibly connected with it. A line, however, drawn across the lower surface of cerebrum, immediately behind the posterior extremity of the corpus callosum, at a right angle with the longitudinal fissure, will form the anterior boundary, to the posterior lobes of the brain. The lower surface of this lobe rests upon the tentorium, and can only be seen on the base of the brain by raising the cerebellum and tentorium from it, when it will be found to be concave, and face a little inwards. The posterior lobe of one side is separated from the other, as has already been described, by the longitudinal fissure.

In taking a general view of the under surface of the cerebrum, we observe its anterior lobes separated by the longitudinal fissure, which extends backwards as far as a pyramidal eminence, which closes it posteriorly.

The base of this pyramidal eminence is directed backwards, and its apex forwards: its anterior sharp edge is inserted like a wedge between two convolutions. From its lower surface, three striæ of white medullary matter extend backward: of these, the outermost is the longest, and extends to the fissura Sylvii; the middle one passes rather more inwards, towards the mesian line; while the internal one, which is the shortest but broadest, bends gently upwards and backwards, to the posterior extremity of the longitudinal fissure, and becomes connected with the corpus callosum. To the point of this pyramidal eminence, the olfactory nerve is attached.

Immediately behind this eminence is placed a flat surface of medullary matter, extending outwards and backwards from the pyramidal eminence to the fissura Sylvii: it forms, as it were, the posterior and under surface of the anterior lobes. It is partly covered by the inner lobule of the middle lobe of the brain, and the commissure of the optic nerves, which must be raised to show it to its full extent, when it will be seen to be pierced by a number of small holes.

The *commissure of the optic nerves*—is next to be observed, which is situated immediately beneath the portion of brain just described, and is formed partly by the union, and partly by the decussation of the fasciculi of these nerves. From the commissure posteriorly there proceeds the trunk of the optic nerve, on either side, which winds at first backwards and outwards, then turns inwards, under the crus cerebri, becoming flatter as it passes backwards to the point where it arises; which will be hereafter described. This portion of brain, has been termed the tractus opticus, and is covered in the greater part of its extent by the inner edge of the middle lobe of the brain. Immediately behind the commissure of the optic nerve, is placed a portion of medullary matter, which is termed the *tuber cinereum*, and which passes backwards to the corpora albicantia, being bounded laterally by the anterior extremities of the crura cerebri. The upper surface of the tuber cinereum, forms a part of the floor of the third ventricle. Its inferior surface is attached to the *infundibulum,* which is a process of reddish medullary matter, that extends downwards and forwards to the pituitary gland, which is placed in the sella tunica of the sphenoid bone, between the dura mater, and tunica arachnoides.

The *pituitary gland*—the use of which is entirely unknown, is a dense substance, of an irregular figure, and somewhat like a gland; it is divided unequally into two portions, the anterior of which is the larger and firmer.

Immediately behind the tuber cinereum, two small, white, rounded bodies, about the size of peas, will be seen, which are termed—

The *corpora albucantia,* or *processus mammillares.*—They are placed in apposition with one another, and are connected by a thin process of grey matter; these bodies form the terminations of the anterior crura of the fornix Behind, and between them, the pons varolii, and the crura cerebri, there is placed a triangular process of medullary matter, which is termed—

The *substantia perforata,* or *pons Tarini*—it forms a part of the floor of the third ventricle, and is perforated by small foramina.

The *crura cerebri,* are the last parts to be described on the under surface of the cerebrum, which may be shewn without dissection. They are two rounded bodies, about three-quarters of an inch in length, which extend from the pons varolii, passing forwards to the under surface of the hemispheres, in which they seem to be lost. As they leave the pons varolii, the crus cerebri of the one side is close to that of the other; but as they pass forwards to the hemispheres, they diverge, the interspace being filled up by the pons Tarini.

Of the Exterior of the Cerebellum.

The *cerebellum* forms the second division of the central mass of the nervous system. It is much smaller than the cerebrum, being less than a third of its size. In the adult, it is estimated at one-eighth of the weight of the cerebrum, and in a new-born infant, only one-seventeenth.

It is lodged in the inferior fossa of the occipital bone, below the tentorium. Its exterior presents a reddish grey color, and its consistence is less firm than that of the cerebrum; instead of convolutions, it is divided by a number of concentric lamellæ, which are termed folia cerebelli; they are from a line to a line and a half in thickness, and enclose one another, so that if a sulcus be opened between any two of them, several other lamellæ will be found between, smaller and more irregular in their form. The cerebellum is divided into two lateral lobes, posteriorly by a fissure which receives the falx minor, and anteriorly by the deep depression of the medulla oblongata.

The upper surface of the cerebellum is flat, inclined obliquely backwards and outwards, and presents in its middle and fore part a projection, which is termed—

The *processus vermiformis superior*—produced by the union of the lamellæ of the two sides of the hemispheres of the organ

There appear to be from sixty to seventy folia, which compose the upper surface of the cerebellum.

The inferior surface of the cerebellum, presents a deep fissure, in which is lodged, anteriorly, the commencement of the spinal marrow; while posteriorly, it is divided into two, by an eminence termed—

The *processus vermiformis inferior.*—This is made up of several short transverse folia, which present, anteriorly, a process which has been termed the mammillary process.

On each side, the cerebellum presents on its inferior surface a convex rounded lobe, divided into four smaller lobules, which describe concentric arches, ending in the middle depression.

The circumference of the cerebellum is interrupted, anteriorly and posteriorly, by the two notches, which have been already described, as containing the falx minor, and commencement of the medulla oblongata. On each side of the posterior notch, the circumference of the cerebellum presents a distinct projecting lobule, composed of laminæ resembling the other lobes of the cerebellum.

Of the Exterior of the Pons Varolii.

This part of the brain, may be considered as a centre of communication between the cerebrum, cerebellum, and medulla oblongata; it presents a quadrilateral figure, its length, breadth, and thickness, being nearly equal. Its anterior and under surface is composed of transverse fibres, passing from the cerebellum and forming a commissure between its two lobes, in the centre of which it is marked by a broad horizontal line, in which is placed the ramulus basilaris. It embraces the crura cerebri, passing partly around them like a ring, from which it has been sometimes termed the tuber annulare.

The posterior and upper surface of the pons varolii, is entirely concealed by the under surface of the cerebellum; it is connected with the tubercula quadrigemina; but as these parts cannot be demonstrated without dissection, we shall defer their minuter description until we examine the internal organization of the brain. The anterior extremity of the pons varolii, is bounded by the crura cerebri; the inferior, which is smaller, is bounded by the spinal marrow; while laterally, it is connected with the cerebellum.

Having enumerated the various parts upon the exterior of the brain, and pons varolii, I shall next describe the coverings of the spinal marrow.

Of the Coverings of the Medulla Spinalis.

The *dura mater*—passes through the foramen magnum into the vertebral canal, forming a membranous sheath to enclose the spinal marrow.

The external surface of the dura mater spinalis, does not adhere to the vertebræ, but forms a sheath, free from the motions of the bony canal which contains it. Anteriorly, it forms a slight connection with the posterior surface of the common proper posterior ligament of the bodies of the vertebræ; but here there is comparatively so slight a motion, that it does not interfere with the functions of the spinal marrow. On the sides of this sheath, openings may be observed through the dura mater for the passage of each nerve arising from the spinal marrow; and as they descend, they become wider and more oblique, so as to resemble canals, more than foramina. It is within these canals that the anterior and posterior filaments unite to form one nerve, around which the dura mater forms an envelope, which having passed through the vertebral foramen, is lost in the common cellular tissue; not becoming continuous with the periosteum of the vertebræ, as the dura mater does with the pericranium in passing through the foramina of the skull.

The internal surface of the dura mater vertebralis, is lined by the tunica arachnoides.

At the sacrum and os coccygis, the dura mater vertebralis terminates, by being connected to those bones, by some irregular fibrous bands.

The *tunica arachnoides*—of the spinal marrow, is reflected from its surface upon the dura mater, in the same manner as within the skull from the brain. Laterally, the arachnoid membrane gives off an envelope to each nerve, which passes with it into its dura matral canal, as far as its exit, when it is reflected, and forms a *cul de sac*, closing the opening.

It is reflected in a similar manner, from the anterior and posterior spinal vessels, upon the dura mater; and on arriving at the lower extremity of the spinal marrow, it forms a long cylindrical canal, which passes to the extremity of the sacrum, where it terminates by sending coverings to the bundles of the lumbar and sacral nerves, and being reflected from them to the dura mater.

The *pia mater*—forms a prolongation from the brain to the spinal marrow, similar to the other membranes; becoming, immediately it has passed through the foramen magnum, thicker, stronger, and of a paler color: having now a new function to perform, namely, that of protecting the spinal marrow from the motions of the spinal column. It is in close contact with the medulla spinalis, and forms an immediate investment or neurilema to the spinal nerves. Cloquet, from the difference of color and thickness in the pia mater spinalis, from that of the brain, seems inclined to consider it as a separate structure; but its continuity from the head to the spinal column, does not warrant such a division.

These three membranes are common to the brain, and spinal marrow; but the latter is also furnished with membranes, which are proper to it; and according to Cloquet, the pia mater is classed in this order.

The *ligamentum dentatum.*—From the spinal marrow being suspended within the canal formed by the dura mater, it is necessary that it should have some ligamentous structures to maintain its situation, and it is the ligamentum dentatum which performs this office. It is continued from the foramen magnum, to the inferior extremity of the spinal column: in this course presenting from twenty to twenty-two processes or denticulations, between the points at which the nerves pass out of their dura matral sheath. The first process is attached to the margin of the foramen magnum, and is placed between the vertebral artery and the lingual nerve; the last, is between the twelfth dorsal and first lumbar nerves.

This membrane has been considered as a prolongation of the pia mater; but it appears to be a distinct structure, although connected with it by means of dense cellular membrane. The form of these denticulations is triangular, the bases being attached to the pia mater of the sides of the spinal marrow, between the anterior and posterior filaments of the spinal nerves; and their apices are connected to the dura mater:—the surfaces of the membrane being covered by the tunica arachnoides, which may be separated by sufflation.

Of the Exterior of the Spinal Marrow.

The spinal marrow commences at the pons varolii, and terminates at the first or second lumbar vertebra — the greater part of it being enclosed in the vertebral canal. In a full grown adult, it is about thirty inches in length; it differs in thickness in different parts of its extent, but is not more than an inch thick in any part ; and its diameter is about half an inch. A portion of the spinal column is within the skull, resting on the cuneiform process of the occipital bone. Hence the division of the spinal marrow, into medulla oblongata, and medulla spinalis.

The weight of the spinal marrow, varies—being in the adult, from 1-19th to 1-25th part of that of the brain; while in the new-born infant, it is not more than 1-40th part. In its extent it varies in size, being first large, where it commences from the pons varolii, from which it is separated by a distinct and deep fissure.

In the upper part of the cervical region, it is contracted ; but as it gains the fourth cervical vertebra, it becomes again enlarged—contracting a second time at the seventh cervical vertebra. In the upper part of the dorsal region, its bulk increases, diminishing in size as it descends, until it terminates by an oval tubercle, which is variable in size and form.

The *medulla oblongata*—commences at the pons varolii, and terminates at the foramen magnum ; its anterior surface rests upon the cuneiform process of the occipital bone, and is more rounded than its posterior surface.

This portion of the spinal marrow, is divided into six distinct pillars by sulci; the anterior sulcus, which is much deeper above than below, continues along the whole extent of the spinal marrow, and divides it into two distinct pillars. At the upper part of these pillars, are the *corpora pyra-*

midalia; they extend from the pons varolii to the atlas, as very distinct enlargements, placed between the corpora olivaria; but below this point, they are much less obvious. And about an inch below the pons varolii, some of the fibres of the corpus pyramidale of one side, cross obliquely the anterior fissure, to join those on the opposite, producing a decussation; it is only the inner fibres, or those nearest to the sulcus, which decussate; while the outer ones continue uninterruptedly upward, through the pons varolii, into the cerebrum, in a manner hereafter to be described.

The two lateral pillars, have eminences on their upper portions, termed the *corpora olivaria*—which are separated from the anterior pillars by a superficial groove. They are about an inch in length, of an oblong form, larger in their centre than at their extremities, and of a white color. Their upper extremity has been described by some anatomists, to terminate abruptly at the pons varolii; but it will be hereafter shewn, that it passes through the pons varolii to the corpora quadrigemina. The posterior surface of the spinal marrow, at its upper extremity, is divided by a deep fissure, termed the calamus scriptorius, into two pillars, termed the corpora restiformia—which we shall hereafter find contribute to the formation of the cerebellum.

According to Sir Charles Bell, there is a fissure separating the corpora restiformia from the corpora olivaria—and which is continued from the lower extremity of the corpora olivaria, containing a white line, which separates the anterior from the posterior pillars, in the whole course of the spinal marrow. It is less obvious below than above, but does not extend into the pons varolii. This, Sir Charles Bell has termed the tractus respiratorius; it gives origin to the nerves regulating the motion of the respiratory muscles.

The spinal marrow below the medulla oblongata, which has already been mentioned as not being of the same size throughout, is divided into pillars by the continuation of the anterior and posterior sulci, into which the pia mater enters. By minute examination both of the anterior and posterior surface, little transverse grooves may be seen, which are more distinct behind than before; particularly in the space between the last cervical and ninth dorsal vertebra.

From the spinal marrow thirty-one pairs of nerves arise, which are symmetrical, double-rooted, and receive distinct filaments from the anterior and posterior pillars: by the former of these, the power of motion is communicated; while in the posterior root, resides that of sensibility. For this remarkable physiological fact, one of the greatest discoveries of modern times, we are indebted to Sir Charles Bell.

Having considered the exterior appearances of the centres of the nervous system, we shall now proceed, by dissection, to investigate their interior, and more intimate organization.

Of the Interior of the Brain.

This dissection may be prosecuted, either according to the old method of demonstrating the parts from the superior to the inferior surface; or according to the plan of Doctors Gall and Spurzheim, of tracing the connection of the pillars of the spinal column from the basis into the interior of the brain; or according to the mode of Dr. Foville, of Rouen, which I shall afterwards point out more particularly by a diagram. Notwithstanding the evident superiority, in a scientific point of view, of the plan adopted by Doctors Gall and Spurzheim; still, in consequence of the delicacy of manipulation, and the number of brains required to follow the fibres through every part, I find it more advantageous to teach the anatomy of the brain according to the old plan; adding, at the same time, to the names given to individual parts, their continuity according to the demonstrations of the above-named anatomists.

To demonstrate the interior structures of the brain, we commence by separating the hemispheres of the cerebrum from each other, at the longitudinal fissure; by which we expose, in the centre of this fissure, a mass of white medullary matter, from three to four inches in length, and nearer to the frontal than to the occipital bone, called the *corpus* *callosum.* This view being very limited, the next part of the dissection consists in cutting off each hemisphere on a level with the corpus callosum; which is effected, by passing the knife under the overlapping edges of the hemispheres, which have been termed their labia, and directing the section outwards, in such a manner as not to open the lateral ventricles.

The hemispheres being removed, on either side of the corpus callosum may be observed, that peculiar arrangement of white medullary matter forming the centre, and of grey or dark cortical substance which forms the exterior. This general view is termed the centrum ovale, which term is useless, beyond the denomination of a mere appearance.

The structure of the medullary and cortical parts should now be examined. The *medullary* is the denser of the two, and its greater firmness seems to depend on its being supplied with less fluids than the cortical part. In this section, the medullary substance presents a greater mass than the cortical, and exhibits numerous delicate red spots, from the division of its minute blood-vessels.

In many situations, the medullary substance of the brain is evidently fibrous. With respect, however, to its minute organization, there is but little known: some anatomists, have considered it solid; others, tubular; while there are those, who maintain that it is made up of a number of small globules: still, however, admitting it to be fibrous, we are ignorant of its ultimate structure.

The *cineritious* or cortical substance, is a soft, spongy, vascular matter, and of a grey color; it not only forms the exterior of the brain, but is also found distributed with the white medullary matter within the interior of the organ. It has been considered to be composed entirely of blood-vessels, probably from its red color in children, its grey appearance in old age, and from its colorless state in dropsical and emaciated persons. Its color is destroyed by maceration, acids, and alcohol. When examined by the microscope, it appears to be composed of minute globules;

but its ultimate structure is as little known as that of the medullary part. Doctors Gall and Spurzheim have given it as their opinion, that the cortical part is the matrix of the medullary filaments; but this hypothesis is overthrown at once, by the fact, that in the developement of the brain, the cortical part is not formed first, but subsequently to the medullary. Dr. Foville considers it as the chief seat of the mind, or the perceptive part of the brain; while the fibrous medullary substance, he considers, conveys impressions, both to and from the perceptive parts.

Having taken this view, the corpus callosum again claims our attention.

The section of the hemispheres having been completed, the whole of the upper surface of the corpus callosum is brought into view; it is arched from before backwards; its anterior extremity is smaller than the posterior, the former being half an inch, the latter three quarters of an inch broad.

Along the mesian line, a little projection may be observed, which is bounded on either side by little furrows; the intermediate longitudinal ridge is termed the *raphé;* it is made up of longitudinal fibres intersecting the transverse fibres of connection, between the hemispheres and corpus callosum, and is supposed by Gall and Spurzheim to be for the purpose of forming a longitudinal commissure, or bringing into reciprocal influence the anterior and posterior fibres of the hemispheres; while the transverse fibres act from side to side. Dr. Foville, however, has a different view with respect to the formation of the corpus callosum, and considers it as the immediate commissure of the crura cerebri, rather than that of the hemispheres; but as he admits of the transverse fibres of the hemispheres being connected with the corpus callosum, it is clear that this body must be equally a commissure to both parts.

The longitudinal furrows, have been described as being formed by the pressure of the blood-vessels of the corpus callosum; but as the edges of these grooves are composed of longitudinal fibres, they appear rather to be a distinct formation, which assists in producing the longitudinal commissure.

Transverse fibres may be distinctly observed extending from these, as well as from the raphé, into the hemispheres; the anterior fibres passing obliquely forwards and outwards, the posterior outwards and backwards, and the middle taking a transverse course.

The anterior extremity of the corpus callosum, may be seen upon separating the anterior lobes of the brain from each other, to bend downwards and backwards, being connected on either side with the anterior lobes, and in the middle it passes completely into the base of the brain, to be connected with the tuber cinereum and optic commissure.

The posterior extremity of the corpus callosum, may be viewed by separating the posterior lobes of the cerebrum, when it will be found broad, and a little concave, and bent downwards to be connected inseparably with the fornix, and the hippocampi majores. The under surface of the corpus callosum, forms the roof of the lateral ventricles of the brain, which are next to be laid open and examined.

The mode of opening them is to make an incision on either side of the raphé, about two inches and a half in length, leaving a space of about a fourth of an inch between the two incisions; and then by turning the roof on either side outwards, in the manner of a flap, the two lateral ventricles are exposed, with the portion of the corpus callosum left, separating the one from the other.

The ventricles which we have thus laid open, present a quadrilateral figure, and contains the following parts.

First, the *corpora striata:* these are pyriform bodies, having large round extremities in front, converging towards each other, while their posterior extremities are pointed, and pass backwards and outwards. They are vascular, and present a cineritious or cortical surface; when cut into, however, they consist of alternate layers of cineritious and medullary matter, the latter of which may be traced from the crura cerebri, through the corpora striata, to the anterior parts of the cerebrum. Gall and Spurzheim, from the intermixture of the cineritious with the medullary matter in these bodies, have considered them as ganglia, from which the anterior parts of the hemispheres of the brain are produced; and term them, therefore, the anterior or superior cerebral ganglia.

Behind the corpora striata, and between their posterior diverging crura, are placed—

The *thalami nervorum opticorum*—which are considered by Gall and Spurzheim as the posterior, or inferior cerebral ganglia; a comparatively small portion of these can only be now seen; they are firm white bodies, presenting an external medullary smooth surface, but are cineritious within, as we shall hereafter have occasion to describe. At the point of junction between the thalami nervorum opticorum and the corpora striata, there may be observed a semi-transparent, white, fibrous substance, commencing at the anterior extremity of the optic thalamus, and being directed backwards curves downwards, gradually contracting until it is lost upon the corpus geniculatum externum. This line is termed the *tænia semi-circularis*, and perhaps may be considered as a commissure between the thalami and corpora striata.

In this stage of the dissection, the next and last parts to be observed within the lateral ventricles, are the *plexus choroides*. It is but a small portion, however, of them which can be now seen; they are composed of blood-vessels, connected with each other by pia mater, and overlap the tæniæ semi-circulares, and consequently the point of junction between the thalami and corpora striata.

By prosecuting the dissection a little farther, we shall find that the lateral ventricles become more extensive, namely, by projecting forwards and outwards, to form the anterior cornua; backwards and inwards, to produce the posterior cornua; and backwards, outwards, downwards, forwards, and inwards, to form the descending cornua.

The *anterior cornua*—pass outward, consequently diverging from each other, and surround the anterior extremities of the corpora striata, which they are said to contain; as well as the converging fibres of the inferior convolutions of the anterior lobes, which are passing to the anterior extremity of the corpus callosum.

The *posterior cornua*—proceed backwards into the posterior lobes of the cerebrum, converging in their course, and contain some fibres of medullary matter, which have received the name of the *hippocampus minor;* but these are, in fact, the converging filaments of the posterior lobes, passing to the corpus callosum.

The *inferior cornua*—as may be supposed, from the intricate direction they take, are difficult to lay open; but the knife may always be directed, by following the course of the plexus choroides.

The parts to be observed in each of these cornua, are, a continuation of the plexus choroides, the tænia hippocampi, the hippocampus major, terminating in the pes hippocampi; and outside of these parts, the eminentia collateralis.

The *plexus choroides*—which is found in this cornu, is continuous with that found in the body of the lateral ventricles; it passes into the interior of the brain, at the anterior extremity of the descending cornu, from the fissura Sylvii; and in its course upwards, towards the body of the lateral ventricle, it covers the pes hippocampi, tænia hippocampi, and hippocampus major, in succession. This plexus must be raised, to expose—

The *tænia hippocampi, or corpus fimbriatum*—or posterior crus of the fornix, which passes downwards along the concave edge of the hippocampus major, towards the pes hippocampi—terminating, however, before it reaches it.

Hippocampus major—or cornua anmonis, is composed of a large projection, which is curved upon itself, presenting a convexity outwards and backwards, and a concavity forwards and inwards. Its superior surface is free, being within the lateral ventricles, and covered by the plexus choroides; its posterior extremity divides into two sets of fibres, to be connected with the corpus callosum, and with the hippocampus minor of the posterior cornu. Its anterior extremity, which is situated in the anterior and inferior extremity of the descending cornu, close to the fissura Sylvii, is broad and bulbous, marked with furrows, which, from a fancied resemblance, has been termed the pes hippocampi. Its under surface is connected with the convolutions of the middle lobe of the brain, and its concave inner edge is covered by the tænia hippocampi, or corpus fimbriatum, which we shall find hereafter to be a continuation of the fornix; between the tænia hippocampi, and the concave edge of the hippocampus major, a narrow cineritious line may be observed, which has been termed the *corpus denticulatum.* The hippocampus major is to be considered, therefore, as bringing into connection the inferior convolutions of the middle lobes of the cerebrum, with the corpus callosum.

The *eminentia collateralis*—is nothing more than the outer wall of the posterior part of the descending cornu, formed by a projecting convolution of the middle lobe of the cerebrum.

It is to be remembered, that in the opening of the lateral ventricles, a portion of the corpus callosum was left, forming a division between the two lateral ventricles; by raising this cautiously with the handles of two knives, a layer of semi-transparent medullary matter will be observed, passing downwards to be connected with the fornix; so that, in fact, the corpus callosum, the fornix, and the connecting medullary layer, termed the *septum lucidum,* form a separation between the two lateral ventricles.

To examine these parts more minutely, the corpus callosum should be cut transversely, and one half should be turned forwards and the other backwards; under the anterior portion a lamina will be found on either side, connecting the corpus callosum with the fornix, and beyond it, the upper with the lower portion of the corpus callosum; the space between these two laminæ, being termed the fifth ventricle.

The corpus callosum is next to be traced, as we have hitherto only spoken of its superior surface. Anteriorly, it will be seen to pass downwards, within the great longitudinal fissure, winding around the anterior rounded extremity of the corpus striatum, forming there the anterior boundary of the lateral ventricle, passing under the corpus striatum, to form the anterior part of the floor of the same cavity, and terminating in the base of the brain, by being connected with the tuber cinereum. The corpus callosum, posteriorly, terminates by being connected with the fornix, the hippocampus major, and the hippocampus minor.

The *fornix*—rests upon the pia mater, which separates it from the thalami nervorum opticorum; it should now be cut through near its centre, and reflected backwards and forwards, in the same manner as the corpus callosum; the posterior crura may be traced, passing backwards behind the thalami, downwards and outwards upon the hippocampus major; terminating in the descending cornu of the lateral ventricle, by what has already been named the tænia hippocampi. Upon the under surface of the posterior portion, a few prominent striæ, placed obliquely with respect to each other, may be observed, which are produced by the blood-vessels of the pia mater; and this appearance has been termed the lyra Davidis.

By the anterior portion of the fornix being directed forwards, it is seen to be divided into two cylindrical bodies, termed the anterior crura; these separate more from each other as they pass forward, between the two thalami nervorum opticorum, behind the anterior commissure, to terminate in the corpora albicantia in the base of the brain. Just as these anterior crura are bending downwards, between the anterior extremities of the thalami, they leave an opening behind them, and underneath the origin of the tæniæ semicirculares, by which the lateral ventricles communicate with the third, and where the plexus choroides meet to terminate in the venæ Galeni. This has been termed the foramen of

Monro; but its existence as an opening, is doubtful in the healthy state of the organ.

The fornix, when viewed under the corpus callosum, and resting upon the pia mater which covers the thalami, presents a triangular figure, with its base behind, and apex or narrow part in front; and from covering the third ventricle, has been termed the fornix: although it is to be remembered, that the pia mater which is under the fornix, forms the real roof to the third ventricle, proceeding from one plexus choroides across to the other, and forming what is termed the *velum inter-positum;* in the middle of which veins may be observed, passing to form the vena magna Galeni, which is directed backwards, between the posterior lobes of the cerebrum, and the cerebellum, to terminate in the torcular Herophili.

To prosecute the dissection still farther, the plexus choroides, with the velum inter-positum, are to be raised from the upper surfaces of the thalami nervorum opticorum, when the whole of those bodies will be brought into view.

Each thalamus nervi optici, presents an upper surface, within its corresponding ventricle; an inferior surface, forming the roof of the descending cornu of each ventricle; an external edge, connected with the corpus striatum, and the hemisphere of its own side; and an internal edge, which is directed towards the opposite thalamus. On the posterior extremity of each thalamus, are placed two slight projections, which are termed—

The *corpora geniculata*—these are connected by medullary striæ to the corpora quadrigemina. The outer projection, or corpus geniculatum externum, is also united with the origin of the optic nerve.

The outer or contiguous edge of the thalamus with the corpus striatum, presents the grey line, which has already been described under the name of the tenia semi-circularis; and on its inner edge, a white fasciculus may be seen passing backwards, as will be hereafter described.

The space between the two thalami, presents a cavity or a longitudinal fissure, which is termed—

The *third ventricle*—this is bounded above, by the velum inter-positum; below, by the tuber cinereum, and pons Tarini; and laterally, by the thalami nervorum opticorum. In this cavity, there are also to be observed the following parts—three commissures, the anterior crura of the fornix, and four openings.

The *middle or soft commissure*—may be exposed by separating the thalami nervorum opticorum, gently from each other. It is of a whitish grey color, connecting the thalamus of the one side with the other. In front of this commissure, and before the descending anterior crura of the fornix, is placed a white, transverse, cylindrical cord, termed the anterior commissure. This sinks into the substance of the hemispheres, extending laterally through the corpora striata, in which bodies they are lost.

The third ventricle, is also bounded behind by a *posterior commissure*, which is thicker and shorter than the anterior, but of the same form and direction, extending a few lines on either side into the thalami nervorum opticorum.

The space between the anterior edge of the middle commissure and the anterior commissure, is termed the *foramen commune anterius;* and the space between the posterior edge of the middle, and the posterior commissure, is termed the *foramen commune posterius.* Besides these, there are two outlets or passages from the third ventricle—the one placed beneath the anterior commissure, and between the two anterior crura of the fornix, leading downwards to the pituitary shaft, and is named the *iter ad infundibulum.* It is formed into a *cul de sac*, by a reflection of the tunica arachnoides. There is also a second passage, which is placed immediately under the posterior commissure, and which leads through the aqueduct of Sylvius to the fourth ventricle; this is named the *iter a tertio ad quartum ventriculum.*

The next step to be taken in the dissection of all those parts of the brain which can be seen from the upper surface, is to tear the pia mater farther back, which passes over the pineal gland and corpora quadrigemina, in order to expose them. This, however, is facilitated by cutting off the posterior lobes of the cerebrum.

The *pineal gland*—rests upon the upper surface of the superior two ~~of the~~ corpora quadrigemina, which are sometimes called the *nates*. This gland is of a greyish color, of a soft pulpy consistence, and variable in form. At its fore part, it receives the two white cords, which have already been described as running along the inner edge of each thalamus, under the name of the peduncles of the pineal gland, and which, as it were, holds it in its situation. The use of this small body, is entirely unknown; and what is most extraordinary, it contains a considerable quantity of silicious matter, in the form of minute sandy particles, of different sizes, and variable in its quantity in different subjects. The pineal gland should now be raised, so as to expose entirely the corpora quadrigemina, which will be found to be connected in front with the thalami nervorum opticorum, and inferiorly with the processus ad testes and the valve of Vieusens. These bodies are found only in the mammalia; reptiles, and birds having but one pair of tubercles.

Above the tubercula quadrigemina, between them and the under surface of the fornix and corpus callosum, the fissure of Bichat is placed, through which the tunica arachnoides passes to line the ventricles. By raising the superior vermiform process of the cerebellum, two rounded white cords may be seen, proceeding from the cerebellum to the inferior or smaller bodies of the corpora quadrigemina, called also the *testes*. These cords are termed the *processus e cerebello ad testes*—which are united to each other by a white medullary band or layer, forming a commissure to these processes; it is called the valve of Vieusens, and may be readily demonstrated by passing a blow-pipe under the posterior commissure of the third ventricle, into the iter a tertio ad quartum ventriculum; when, by inflation, the roof of this iter, or the valve of Vieusens will be raised.

These are all the parts of the brain which can be traced and examined from its upper surface: to prosecute, therefore, the dissection of the cerebellum and pons varolii, we must commence from the base of the brain, tracing its structure from the spinal marrow.

The *spinal marrow*—as we have already observed, is formed of a substance differing in consistence, at different periods of life. Its exterior presents a layer of white medullary matter, which contains cineritious matter in its interior—an arrangement the reverse to that of the brain. In making a transverse section of the spinal marrow, the cineritious matter is divided into a middle, and two lateral portions; the first is transverse, and is thicker and broader in the cervical than in the dorsal region, and again enlarges in the lumbar region. The two lateral portions are curved, their convexities facing towards each other, and their concavities outwards. Their posterior edges, are prolonged nearly to the posterior collateral grooves; while anteriorly, they are shorter and thicker.

The *corpora olivaria*—are covered, like the rest of the spinal marrow, with white medullary matter; and in their substance they contain a dark cineritious matter, which has been termed the corpus dentatum.

It has been asserted, that a canal runs through the whole length of the centre of the spinal marrow, proceeding from the calamus scriptorius; but others have supposed, that this is merely produced by artificial means.

Gall and Spurzheim, describe a canal in each lateral portion of the spinal column, commencing in the lumbar region, and continuing upwards, through the whole length of the spinal marrow, into the pons varolii, under the tubercula quadrigemina; and passing through the crura cerebri, finally enter the thalami nervorum opticorum, in the interior of which, they state they may be inflated to a considerable size: but the early progress of developement being now so well understood, it is proved that these canals do not exist.

By following the pillars of the spinal marrow into the substance of the brain, we shall be enabled to explain the manner in which these pillars are at least connected with, if not producing the cerebellum, pons varolii, and cerebrum. We shall commence with—

The *posterior pillars*, or *corpora restiformia*—which proceed upward and outwards from the medulla oblongata into the cerebellum. A portion of these fibres also continue forward, beyond the cerebellum, to be connected with the corpora quadrigemina, termed the processus e cerebello ad testes; while a third portion of the medullary matter of the cerebellum, crosses transversely on the under surface of the pons varolii, to be connected with the opposite lobe of the cerebellum—producing its great commissure.

Thus it may be said, that the medullary part of the cerebellum is made up of three sets of fibres of medullary matter. The one proceeding upwards and outwards, from the spinal marrow; the second, forwards, to the corpora quadrigemina; and the third, inwards, on the pons varolii: each of these being connected with that of the opposite side, by distinct commissures.

The corpora restiformia, where they diverge from each other to enter the lobes of the cerebellum, leave a space which is called the fourth ventricle; in which may be observed a white medullary band, crossing from the one restiform body to the other, producing the commissure between the two. The second commissure, is that portion of medullary matter connecting the processus cerebello ad testes, which is named the valve of Vieusens: while the third, the great commissure of the cerebellum, forms the transverse fibres of the under surface of the pons varolii.

The whole of the medullary matter of the cerebellum, is surrounded by a cortical substance, which presents different appearances according to the sections which are made. Thus, if the transverse fibres forming the great commissure be traced in the direction of their course, by a lateral section of one of the lobes, the large medullary mass will be exposed; in the centre of which is a rounded grey substance, of an inch in length, termed—

The *corpus rhomboideum, vel serratum*—and which has been considered by Gall and Spurzheim, as the great ganglion of the cerebellum, for the production of its medullary fibres. It was the appearance of this substance, which led to the controversy between Dr. Spurzheim, and the late Dr. Gordon, of Edinburgh.

If a vertical section be made of one lobe, a particular arrangement of the cortical and medullary matter is presented to view; which has obtained the name of the *arbor vitæ,* from its foliated appearance.

The cerebellum encloses the fourth ventricle, the roof of which is formed by the valve of Vieusens; the sides, by the processus e cerebello ad testes, and by the cerebellum; and the floor, by the corpora restiformia of the medulla oblongata. Into this opening the pia mater enters, and is here sometimes said to form a plexus choroides minor.

We may next trace the organization of the cerebral protuberance, named the *pons varolii*—which is the smallest part of the brain; it is placed between the cerebrum, cerebellum, and medulla oblongata, and is intimately connected with each of these parts.

The under or anterior surface, has already been noticed, as being made up of the transverse fibres forming the great commissure of the cerebellum.

If these fibres be scraped off, they will be found to be crossed by longitudinal fibres, passing from the corpora pyramidalia, and the corpora olivaria; of the distribution of which, various accounts have been given by different anatomists. Those from the corpora olivaria, according to Gall and Spurzheim, pass through the pons varolii, upon the upper and inner surface of the crura cerebri, to form, with a continuation of the corpora restiformia, the thalami nervorum opticorum, and posterior lobes of the cerebrum; while, according to Dr. Foville, they go no farther than the corpora quadrigemina. The other longitudinal fibres, which enter into the structure of the pons varolii, are a continuation of the corpora pyramidalia, and pass forward from it, forming the under part of the crura cerebri, in which they are separated from the fibres of the corpora olivaria and corpora restiformia, by a portion of grey matter, termed the *locus niger*. This grey matter, according to Gall and Spurzheim, is the ganglion of the crura cerebri, and is considered by them as the origin of its medullary enlargement.

We have already mentioned, that the crura cerebri are connected by a commissure, named the pons Tarini.

The further account of the distribution of the fibres of the crura cerebri, according to the views of Dr. Foville, will be better explained by a plate, to which ample references are given, than by any separate description.

LECTURE XXXIII.

DESCRIPTIVE ANATOMY OF THE NERVES.

The nerves are divided into those which are connected immediately with the brain, and those which arise from the spinal marrow.

Those from the brain, or the cerebral nerves, are distributed to the organs of sensation and volition. They arise in pairs, and are named according to the order of their succession.

The *first pair are the olfactory*—which are placed upon the under surface of the anterior lobes of the brain, in grooves, which protect them from the pressure of that organ. They arise by three distinct filaments, which may be traced for a considerable distance into the substance of the brain; the outer filament is white, the longest of the three, and is directed outwards and backwards into the fissura Sylvii, which in a great measure conceals it. This filament can be traced into the lateral ventricle, arising from the corpus striatum. The inner filament is also white, is shorter than the outer one, and may be traced backwards as far as the anterior part of the corpus callosum. The middle filament is grey or cineritious, has a pyramidal figure, and where the three filaments unite, the olfactory nerve presents a triangular form.

It is closely connected to the under surface of the anterior lobes of the brain, by the arachnoid membrane; as it passes forwards, it gradually enlarges to a bulbous extremity, from the lower surface of which it distributes its filaments to the nose.

The olfactory nerve of the one side, converges towards that of the opposite; and while they rest upon the cribriform plate of the ethmoid bone, they divide into an external, internal, and middle set of rami.

The external principally supply the superior turbinated bones, frequently uniting with each other: the internal ramify upon the pituitary membrane, covering the nasal process of the ethmoid bone: while the middle rami are distributed upon the pituitary membrane, covering the under surface of the roof of the superior chamber of the nose.

The olfactory nerves differ from the other cerebral nerves,—first, in having three distinct filaments by whith they arise, from converging as they pass forward, from being lodged in a groove of the brain, from having no neurilema, from passing through the several foramina; and it is also said by Cloquet, that they do not anastomose with other nerves—but this is to be considered as a matter of doubt.

There is no nerve in the body which offers greater difficulties, in physiological reasoning, than the olfactory, whether we are following the views of Sir Charles Bell, Majendie, Gall and Spurzheim, or Dr. Foville; for they all, more or less, agree in the belief that the cerebrum, which is most intimately connected with the corpora pyramidalia, is for the function of motion, the cerebellum for sensation, and the corpora quadrigemina for organic life. Now this nerve, which arises from the cerebrum, has attributed to it, entirely the sense of smell; nor can we for a moment hold with Majendie, who by experiment, tried to prove that it was the fifth pair of nerves, and not the first, which gives the sense of smell. But may it not be, that the cineritious filament, which this nerve derives from one of the posterior convolutions of the brain, communicates a distinct influence?

The *second pair of nerves*, are the *optic*—they arise from the tubercula quadrigemina, and are peculiar from having a much longer course within, than on the exterior of the skull; and from not furnishing a single branch, from its origin to its termination; it receives two distinct filaments from the superior and inferior corpora quadrigemina, which pass outwards, beneath the thalamus nervi optici; the superior filament being connected with the corpus geniculatum externum, the inferior filament with the corpus geniculatum internum. These filaments then unite to form a soft flat band, which takes its course outwards, and then winding forwards under the crus cerebri in a semi-circular direction, forms what is called the tractus opticus. In passing under the crus cerebri, it is connected with it by its outer convex edge; but its inner concave edge is free. When it arrives anterior to the crus cerebri, it proceeds farther inwards, and escapes from the fissure of the middle lobe of the brain, here becoming more rounded, and resting upon the tuber cinereum, to which it adheres. Just anterior to the pituitary gland, the two optic nerves unite, so as to form a commissure: and much difference of opinion has arisen, whether or not the optic nerves here decussate; the truth, however, seems to be, that some of the fibres decussate, some continue onwards on the same side, while others pass across to the opposite optic nerve, both before and after their union—thus forming the anterior, and posterior edges of the commissure. The optic nerves, after having produced this commissure by the crossing and interlacement of their filaments, again separate, being now cylindrical, and perfectly free from any attachment to the brain, and each is directed forwards and outwards to the foramen opticum of its own side, through which it passes, with the ramulus a. ophthalmicus—above and to the outer side of which vessel it lies. In the second part of its course, each optic nerve is enveloped in a distinct neurilema; but before the formation of the commissure, it is only covered by pia mater, and tunica arachnoides upon its under surface. In passing through the optic foramina, each optic nerve is surrounded by the four straight muscles of the eye, from which it is separated by a considerable quantity of fat, by the ciliary nerves and vessels, and by the ophthalmic ganglion; when the optic nerves arrive at the posterior, internal and inferior part of the eye, they suddenly contract, traverse the sclerotic and choroid membranes, and terminate by expanding into the retina. From the foramen opticum to their termination, numerous small partitions divide the medullary matter of the nerve into distinct fasciculi, passing from the inner surface of the neurilema.

The optic nerve does not enter the globe of the eye in the direction of its long axis, but to its nasal side; nor does it perforate the sclerotic coat through one foramen, but through a cribriform plate.

(3.) The *motores occulorum*, or the *third pair of nerves*—arise from the crura cerebri, as far backwards as the point where the corpora pyramidalia issue from the pons Varolii, forming the upper or anterior part of the tractus motorius of Sir Charles Bell. They also receive grey filaments from the substantia perforata, or pons Tarini.

This nerve issues from the substance of the brain, between the posterior cerebral, and the superior ramuli of the cerebellum. Immediately after its origin, it forms a rounded cord, acquiring consistence from a neurilema, which envelopes it. It takes its course forwards and outwards, to the body of the sphenoid bone, where it penetrates the dura mater to gain the cavernous sinus, at that point losing its covering from the tunica arachnoides. While within the cavernous sinus, it first lies above and to the inner side of the fourth pair, and first division of the fifth pair of nerves; but just at the anterior clinoid process, it is covered by these two nerves, which cross it obliquely, and in their turn become internal to it. It is separated from the ramus a. carotidis internus, by a process of dura mater; just before it enters the orbit, through the foramen lacerum orbitale superius, it divides into a superior and an inferior ramus; the superior, the smaller of the two, passes over the optic nerve, and divides into ramuli to supply the superior rectus muscle, and the levator palpebræ superioris; the inferior, or larger ramus, is beneath and to the outer side of the optic nerve, and the rectus inferior oculi, where it divides into three ramuli, the largest of which is the inner one, and supplies the adductor oculi; the middle one ramifies upon the rectus inferior muscle; while the third and outer ramulus takes the longest course, passes under the ball of the eye to supply the inferior oblique muscle: just at the origin of this ramulus n., a small filament arises, which gains the outer side of the optic nerve, to be connected with the ophthalmic ganglion.

The peculiarity in the distribution of this nerve, is, that although described as a common motor to the eye, it does not supply the adductor oculi, or the superior oblique, while it does furnish a ramus to the inferior oblique muscle.

Sir Charles Bell considers the oblique muscles as involuntary; but if so, here is an instance of an involuntary muscle being supplied by a voluntary nerve: the ramus n., however, which goes to this muscle, is connected with the ophthalmic ganglion, and may therefore, perhaps, be considered as a compound nerve.

(4.) The *nervi pathetici, or fourth pair.*—The nervus patheticus of each side, arises from the valve of Vieusens, by three or four filaments, which unite and form the smallest of the cerebral nerves, passing out just on the outer side of the junction of the crura cerebri with the pons Varolii.

Sir Charles Bell traces the medullary substance of this nerve to the space between the corpora olivaria and corpora restiformia, at the upper part of the tractus respiratorius. As soon as it has emanated from the junction of the crura cerebri with the pons Varolii, it descends, passing outwards and forwards under the crura cerebri, along the inner edge of the tentorium; and having arrived at the posterior clinoid process of the sphenoid bone, it enters the cavernous sinus, penetrating the dura mater, and here losing its arachnoid covering. While within the cavernous sinus, it is first placed below, and to the outer side of the motor oculi, but is separated from it, by a process of dura mater; the nerve then passes forwards towards the foramen lacerum orbitale superius, through the widest part of which, it enters the orbit, and passes above the motor oculi.

The nervus patheticus then inclines upwards and inwards, passes over the superior rectus, and levator palpebræ superioris muscles, being here accompanied by the frontal ramulus of the ophthalmic branch of the fifth pair of nerves; it divides into two or three rami, which are distributed to the superior oblique muscle.

This nerve is peculiar in being distributed to a single muscle of the eye; and Sir Charles Bell is the first physiologist who has attempted to explain its function. Having traced the nerve from the tractus respiratorius, he considers it as the respiratory nerve of the eye; and instances, in proof of his theory, the peculiar expression of the eye, concomitant with violent and difficult respiration.

(5.) The *nervus trigeminus, or fifth pair of nerves.*—This nerve arises by two distinct sets of filaments, the one communicating sensation, and the other motion; and like the spinal nerves, the posterior filaments form a ganglion, while the anterior ones pass out unconnected with it.

The origins of this nerve, should be traced backwards from the place where it first makes it appearance exterior to the pons Varolii, when it will be found, that the anterior fibres can be followed through the pons Varolii, to the corpus pyramidale of its side; while the posterior fibres forming the larger root, take a course downwards and backwards, through the pons, to the corpus restiforme—from which it derives the property of sensation. These filaments uniting as they issue from the substance of the pons Varolii, consist of from eighty to a hundred filaments, collected in one neurilema. It then passes on to the summit of the petrous portion of the temporal bone, and there piercing the dura mater, gains the anterior surface of that bone, where the posterior filaments expand into the Gasserian or semilunar ganglion. While the anterior roots pass beneath the ganglion, without uniting with it, to reach the foramen ovale, by which it passes out of the skull, forming a part of the third division of the fifth pair of nerves. The circumstance of the unganglionic branch passing to supply muscles, as well as its origin from the corpus pyramidale, proves the justness of Sir Charles Bell's theory, regarding the function of this nerve.

The Gasserian ganglion is of a crescentic form, presenting its convexity in a direction forwards and downwards, from which three distinct nervous rami are distributed.

(A.) *Ramus nervosus ophthalmicus*—is the smallest of the three branches; it proceeds forwards from the upper part of the ganglion, under the dura mater, towards the cavernous sinus, which it enters, being separated from the third and fourth pair of nerves by a distinct process of that membrane; being at first placed inferior to those nerves, but afterwards passing above them. While within the cavernous sinus, the ramus ophthalmicus receives one or two filaments from the sympathetic nerve, and almost immediately after divides into three ramuli.

(*a.*) *Ramulus nervosus lachrymalis*—is the smallest and most external and inferior of the three; it penetrates the dura mater above the nervus motor oculi, and passes into the orbit through the foramen lacerum orbitale superius, taking its course on the outer wall of the eye, between the periosteum and abductor oculi, to the lachrymal gland, to which it is distributed, supplying at the same time the upper eyelid.

In this course, the ramulus n. lachrymalis sends off two ramusculi—

(*α.*) The *ramusculus n. spheno-maxillaris*—which is reflected from the ramulus n. lachrymalis, close to its origin, and passes downwards to unite with a ramusculus of the second division of the fifth pair of nerves.

(*β.*) The *ramusculus n. malaris*—takes its course outwards, through a foramen in the malar bone, to reach the cheek, where it unites with filaments of the facial nerve.

(*b.*) *Ramulus n. frontalis*—is the largest of the three ramuli of the ophthalmic ramus, takes its course upwards and inwards, above the levator palpebræ superioris muscle, accompanied by the nervus patheticus; and here it divides into two ramusculi; the inner one—

(α.) *Ramusculus n. supra-troclearis*—passes forwards and inwards along the superior oblique muscle of the eye, as far as its cartilaginous pully, supplying the muscles and skin on the inner canthus, and being lost upon the forehead; it unites in its course, with the ramulus n. lachrymalis, and the ramulus n. nasalis of the ophthalmic ramus.

(β.) The *ramusculus n. supra-orbitalis*—directly it is separated from the ramulus n. frontalis, upon the upper surface of the levator palpebræ muscle, directs itself forwards and upwards to the supra orbitar foramen, through which it passes to gain the forehead, and supply the upper eyelid, uniting with branches of the portio dura, supplying also the corrugator supercilii muscle, and being ultimately lost upon the forehead and vertex.

(*c*.) *Ramulus n. nasalis*—enters the orbit by a separate foramen of the dura mater, and passes between the two heads of the abductor oculi muscle; it then proceeds upwards, forwards, and inwards, passes over the optic nerve, and under the levator oculi muscle, where it sends off, or rather receives—

(α.) A ramusculus from the ophthalmic ganglion—after which it divides on the inner wall of the orbit, into two ramusculi.

(β.) *Ramusculus n. nasalis internus*—is sent off opposite to the foramen orbitale internum anterius, through which it passes to gain the interior of the skull; then enters a bony groove on the upper surface of the cribriform plate of the ethmoid bone, along which it runs to a small fissure upon its anterior extremity, and passes through it, to gain the interior of the nose, dividing there into filaments, some of which are distributed to the pituitary membrane, and others to the integuments at the extremity of the nose.

Sneezing, from the effects of the light of the sun to the eye, and the overflow of tears, upon the application of pungent bodies to the nose, are attributable to this nerve.

(γ.) *Ramusculus infra-trochlearis*—proceeds forwards continuing in the direction of the ramulus nasalis, under the superior oblique muscle of the eye; at the inner canthus of which, and beneath the trochlea, it emerges and divides into numerous filaments, uniting with the infra-orbitar ramuli, and with filaments of the portio dura; supplying also the caruncula lachrymalis, the lachrymal sac, and the exterior of the nose.

(B.) *Ramus n. maxillaris superior*—forms the second division of the fifth pair of nerves; it arises from the centre of the convexity of the Gasserian ganglion, from which it is directed forwards, slightly outwards, and leaves the skull by passing through the foramen rotundum of the sphenoid bone, and enters the spheno-maxillary fossa, which is bounded, above, by the orbit, below, by the pterygo-maxillary canal, in front, by the tuberosity of the superior maxillary bone, behind, by the pterygoid foramen, on the inner side, by the spheno-palatine foramen, and on the outer, by the malar bone. While within this fossa, this ramus receives two filaments from Meckel's ganglion, which is situated below it, and within the spheno-maxillary fossa; and almost immediately after, it gives off the—

(*a.*) *Ramulus n. orbitalis*—which ascends, passes through the spheno-maxillary fissure, and gains the orbit, within which, under the depressor oculi muscle, it sub-divides into two ramusculi—the malar and temporal.

(*α.*) The *ramusculus n. malaris*—is directed upwards and outwards, and unites with the ramulus n. lachrymalis, then passes through a foramen in the malar bone, and is distributed to the muscles and skin of the cheek, uniting with the portio dura;

(*β.*) The *ramusculus n. temporalis*—penetrates the orbitar process of the malar bone, gains the temporal fossa, where it unites with the deep temporal ramusculi of the ramus n. maxillaris inferior; it afterwards pierces the temporal aponeurosis, becomes sub-cutaneous, and accompanies the ramulus arteriosus temporalis superficialis, unites with filaments from the portio dura, and is ultimately lost on the skin of the temple and head.

The next ramulus sent off from the ramus nervosus maxillaris superior, is usually distributed by two or three ramuli called—

(*b.*) The *ramuli n. dentales posteriores*—which are given off behind the tuberosity of the superior maxillary bone, wind around it, and enter small foramina, which perforate the substance of the bone to reach the roots of the three or four last molar teeth; usually one of these ramuli pass externally, without entering the bone, to supply the gums; and another enters the antrum Hymorianum, and is distributed upon its membrane.

(*c.*) *Ramulus n. infra-orbitalis.*—This ramulus appears as a continuation of the main branch, passes through the spheno-maxillary fissure, and enters immediately either a canal or foramen in the orbitar process of the superior maxillary bone, which canal terminates externally in the infra-orbitar foramen, where this ramulus divides into numerous infra-orbitar ramusculi: they are distributed in an external and an internal set, supplying the under eyelid, the caruncula, and lachrymal sac, skin and muscles of the nose, and are united with filaments of the portio dura.

While the infra-orbitar ramulus is passing on the floor of the orbit, it sends off the—

(*α.*) *Ramusculus n. dentalis anterior*—which descends into the antrum, runs to the fore part along its lining membrane, and ultimately supplies the incisor and canine teeth. Within the antrum, this ramusculus supplies the mucous membrane, and unites with filaments of the posterior dental ramusculus.

(c.) *Ramus n. maxillaris inferior*—is the third division of the fifth pair of nerves, and the largest of the three branches; it proceeds from the lower part of the convexity of the Gasserian ganglion: but upon more minute inspection, it will be found to be composed of two sets of fibres, the anterior of which are the softest, flattened, and really emanate from the Gasserian ganglion; while there are fibres concealed by these, larger, whiter, and rounded,—composed of parallel, and not plexiform filaments,—which emanate from the corpora pyramidalia.

These two sets of filaments pass together through the foramen ovale, to gain the zygomatic fossa; in which situation, those filaments of the ramus which had been posterior, wind around the others, and become anterior. When the ramus n. maxillaris inferior has gained the zygomatic fossa, it is placed between the pterygoideus externus muscle, and the pterygoid process of the sphenoid bone; and here it divides into a superior and an inferior ramulus.

(*a.*) *Ramulus n. superior.*—This is placed external to the other, and gives origin to four sets of muscular ramusculi. The first of these supply the posterior surface of the temporal muscle, and are termed—

(*α.*) *Ramusculi n. temporales profundi.*—These are usually two in number, pass upwards upon the periosteum of the temporal fossa, and behind the temporal muscle, in the substance of which they ramify; some, however, pass through its fibres and fascia, to unite with ramifications of the portio dura, as well as with the ramulus n. lachrymalis of the first division, and ramulus n. orbitalis of the second division of the fifth pair of nerves.

(*β.*) *Ramusculi n. masseteres*—(not unfrequently given off in a single branch) take their course outwards, above the pterygoideus externus muscle, pass through the sigmoid notch of the inferior maxillary bone, and supply the masseter muscle. They send also some few filaments to the temporo-maxillary articulation.

(*γ.*) *Ramusculi n. buccales*—are larger than the preceding, and are directed forwards and downwards, first between the two pterygoid muscles, and then between the pterygoideus internus and the ramus of the lower jaw; it passes in front of the coronoid process, and enters the buccinator muscle, which it supplies, as well as the levator anguli oris muscle, and the skin of the cheek and lips.

These ramusculi frequently unite with those of the portio dura, and the ramulus n. infra-orbitalis of the second division of the fifth.

(δ.) *Ramusculi n. pterygoidei*—are two or three in number, are distributed to the pterygoid muscles, and principally to the internal.

(*b.*) *Ramulus n. inferior*—the remaining branch of the third division of the fifth, divides itself into three ramusculi; the first of these, the—

(α.) *Ramusculus n. lingualis, vel gustatorius*—immediately after its division, descends between the pterygoid muscles, and here sends off a filament of communication with the inferior dental ramusculus; and then the corda tympani unites with it; which is a branch from the spheno maxillary, or Meckel's ganglion, and not as was formerly supposed, either a branch of the second division of the fifth, or of the portio dura. The corda tympani, passes with the gustatory ramusculus, first between the pterygoideus externus, and circumflexus palati muscles, then between the pterygoideus internus, and the ramus of the lower jaw, reaching the submaxillary gland, on which it is finally distributed.

The gustatory ramusculus, however, continues on under the mucous membrane of the mouth, between the mylo-hyoideus, and hyo-glossus muscles—being here accompanied with the submaxillary duct; it then ascends above the sublingual gland, and divides into several filaments, which terminate in the papillæ conicæ at the anterior part of the tongue. This ramusculus, during its course sends filaments of communication to the hypoglossal nerve, to the internal pterygoid muscle, and to the sublingual gland.

(β.) *Ramusculus n. dentalis inferior*—is rather longer than the preceding; it descends between the pterygoideus internus, and internal lateral ligament of the temporo-maxillary articulation, and the ramus of the lower jaw, which latter is to its outer side. When it reaches the middle of the internal surface of the ramus of the lower jaw, and just before it enters the posterior dental canal, it sends off the *mylo-hyoideal filament*, which is always protected by a distinct groove in the bone; it passes forwards upon the mylo-hyoideus muscle, distributes filaments to it, as well as to the submaxillary gland, and the anterior belly of the digastric muscle. The ramusculus nervosus dentalis inferior, then enters the posterior maxillary foramen, accompanied by an arterial and a venous ramusculus, all being protected from the action of the pterygoideus internus muscle, by the internal lateral ligament of the temporo-maxillary articulation. The nervous ramusculus continues through the mental canal appropriated to it in the lower jaw, immediately beneath the roots of the teeth, extending from the last to the first molar tooth, distributing filaments to them; it then reaches the anterior mental foramen, and divides into two filaments, one of which still continues within the bone, as far the symphysis of the lower jaw, supplying the canine and incisor teeth, and uniting with the filament from the opposite side, in the middle line of the jaw; the other, or internal filament, passes out of the mental foramen, gains the face, and ramifies on the chin and lips, uniting frequently with filaments from the portio dura.

It may here be remarked, that we have described the ramusculus supra orbitalis, of the first division of the fifth, the ramusculus infra orbitalis of the second division, and the ramusculus dentalis inferior of the third division of the fifth, each in passing through their appropriate foramina, and uniting with the portio dura within a perpendicular line.

(γ.) *Ramusculus n. auricularis, vel temporalis superficialis*—frequently arises by several filaments, which surround the ramusculus arteriosus meningeus medius, and then uniting form one cord, which passes between the condyle of the lower jaw and meatus auditorius externus, being here deeply seated in the substance of the parotid gland; it sends off a filament to the temporo-maxillary articulation, and then divides into several other filaments, which communicate with the portio dura; some of them supply the auricle of the ear, and others lose themselves upon the temple and forehead, uniting frequently with the temporal filaments of the facial, and the occipital filament of the second pair of cervical nerves.

(6.) The *sixth pair, or abducentes*—arise from the corpora pyramidalia, or anterior pillars of the spinal marrow, just inferior to the groove, placed between the medulla oblongata and the pons Varolii; from this point each nerve passes forwards and upwards, on either side of the ramulus arteriosus basilaris, to gain the cavernous sinus, which they enter by passing through the dura mater immediately beneath the posterior clinoid processes; when within the cavernous sinus, each abductor nerve is placed external to the internal carotid ramus, where they receive two or three filaments from the superior cervical ganglion of the sympathetic nerve. The sixth pair of nerves still pass forwards (enclosed within a sheath of dura mater, which separates them from the blood contained within the sinus,) to the foramina lacera orbitalia superiora, through which they pass on either side into the orbit, between the two origins of the abductor muscle, accompanied by the third, and ramulus n. nasalis of the ophthalmic branch of the fifth pair, being ultimately distributed to the abductor muscle by three or four distinct filaments.

(7.) The *seventh pair—portio dura, or facial nerve*—arises from the space between the corpus olivare and corpus restiforme, on either side of the medulla oblongata, close to the lower margin of the pons Varolii. According to Sir Charles Bell, it arises immediately below the origin of the fourth pair; it is above the portio mollis, and to the outer side of the sixth pair, from which it is separated by the corpus olivare. Immediately after its origin, it forms a flat, soft, white cord, which is not immediately enclosed in a neurilema; it continues its course upwards and outwards, accompanied by the portio mollis, which in part receives it in a groove, and they together enter the meatus auditorius internus. Having reached the base of this opening, the portio dura separates from the portio mollis, and enters the canal of Fallopius, which takes a course upwards, outwards, downwards, and backwards, and terminates ultimately in the stylo-mastoid foramen, through which the portio dura runs, and issues from it, to be spread upon the face. Almost immediately after the portio dura has entered the canal of Fallopius, it receives upon its inferior surface, the *videan or nervus innominatus*—which is a filament from Meckel's ganglion, and forms the corda tympani, which will be more particularly described, when speaking of the sympathetic nerve.

While the portio dura is taking its course through the canal of Fallopius, it sends off two rami—

(A.) *Rami musculares*—one of which is distributed to the tensor tympani, and the other to the stapedius muscle. The next branch in the course of the dissection to be described, would be the chorda tympani; but for the doubt which exists, whether it is to be considered as arising from the portio dura, after that nerve has received filaments from the nervus innominatus; or as the nervus innominatus itself, without having united with the portio dura. I shall prefer describing it as a branch of the sympathetic; for although I believe in the union of the two, it may still be considered as a branch of the sympathetic, communicating a compound, as well as a reciprocal influence to the portio dura.

After the portio dura has given off these two muscular branches, it continues its course through the canal of Fallopius, and passes out of the foramen stylo-mastoideum, deeply seated within the substance of the parotid gland; in which situation, it sends off three rami.

(B.) *Ramus auricularis posterior*—takes its course upwards and backwards, upon the anterior surface of the mastoid process, and there divides into an anterior and a posterior ramulus; the anterior passes upwards, in front of the meatus auditorius externus; while the posterior passes behind, both to be distributed to the skin, and muscles of the external ear, uniting with filaments of the cervical plexus.

(C.) *Ramus n. stylo-hyoideus*—expends itself upon the stylo-hyoideus, and the digastricus muscles, being also connected with filaments of the sympathetic, from the superior cervical ganglion, as well with some from the cervical plexus.

(D.) *Ramus n. digastricus*—takes its course outwards and backwards, to be distributed to the posterior belly of the digastric muscle; but also, a considerable branch, passes through it, and divides into two ramuli, one—

(*a.*) *Ramulus n. superior*—rises upwards and inwards, passes behind the internal jugular vein, and unites with the glosso-pharyngeal nerve, just as it escapes from the foramen lacerum basis cranii.

(*b.*) *Ramulus n. inferior*—descends, and passing slightly forwards, unites with the superior laryngeal branch of the par vagum.

After the portio dura has given off these rami, and still while embedded within the parotid gland, it divides into numerous branches, which are frequently uniting with each other, so as to form a complete plexus, which has been termed the *pes anserinus;* and from which there are sent off other branches, proceeding in three distinct sets, in different directions. The first branch, ascends to cross the zygoma, and join the temple; from which course, it is called the—

(E.) *Ramus n. temporo-facialis*—it passes upwards within the substance of the parotid gland, towards the neck of the lower jaw, where it divides into seven or eight ramuli, which are named according to their destination.

(*a.*) *Ramuli n. temporales*—are two or three in number, which pass upward, crossing the zygoma to gain the temple, where they divide into several ramusculi, to supply the temple, the vertex of the head, the front part of the ear, and the muscles and skin of these regions; uniting with filaments of all the three divisions of the fifth pair of nerves, and with those of the cervical plexus.

(*b.*) *Ramuli n. malares*—are also two or three in number; they take their course upwards to the malar bone, where they divide into numerous filaments, to be distributed to the muscles connected with that bone, as the orbicularis palpebrarum, and the zygomatici; and unite with the branches of the first and second divisions of the fifth pair.

(*c.*) *Ramuli n. buccales*—are usually first distributed as three or four ramuli, which take their course transversely, crossing the masseter muscle, and there sub-dividing into three distinct sets of ramusculi: the *superior,* to supply the sides of the nose, and muscles of the upper lip; the *middle,* take their course principally with the parotid duct, and ultimately are distributed to the buccinator, and the other muscles of the commissures of the lips; while the *inferior,* are distributed to the lower lip, uniting with the dental filaments of the third division of the fifth.

(F.) *Ramus n. cervico-facialis*—is a branch of considerable size, and passes obliquely downwards, behind the ascending ramus of the lower jaw, where it divides into two sets of ramuli.

(*a.*) *Ramuli n. supra-maxillares*—as the name implies, are distributed to the face; but they divide into a superior and an inferior set: the *superior,* leave the parotid gland, by which they are at first concealed, cross the masseter muscle, and dividing into four or five ramusculi, ramify on the platysma myoides depressors of the lower lip, and the skin; while the *inferior,* turn over the angle of the lower jaw, and supplying the insertion of the pterygoideus internus, are distributed as the preceding ramusculi, uniting with filaments of the second and third divisions of the fifth pair.

(*b.*) *Ramuli n. infra-maxillares*—are two or three in number, and descend forwards to the anterior and superior part of the neck, dividing into several ramusculi, to supply the platysma myoides and integuments, frequently uniting with filaments from the cervical plexus, and with those of the preceding ramuli.

On taking a view of the distribution of the portio dura, it will be found to supply all the muscles of the face, and to be frequently uniting with the filaments from each division of the fifth pair of nerves, which are also distributed to the same parts as the portio dura. Sir Charles Bell, struck with this fact, directed his mind to the physiology of this arrangement, and has come to the following conclusion:—That the fifth pair, arising by two distinct sets of filaments or roots, are capable, like all the spinal nerves, of communicating both sensation and motion to the parts which they supply; but that the motion which is communicated by the fifth pair, is the motion subservient to the will, while they are under another motatory influence, essentially connected with respiration; and which influence is communicated to them through the portio dura, arising from the tractus respiratorius.

(8.) *Eighth pair, portio mollis, or auditory nerve*—arises from the upper surface of the corpus restiforme, from a small grey band which connects it with the floor of the fourth ventricle. The roots which give origin to this nerve, are united by small striæ with the origin of the nerve of the opposite side, forming a kind of commissure. From this point of origin, the nerve makes its appearance with the portio dura in an angle produced by the junction of the medulla oblongata, pons Varolii, and crus cerebelli. The portio dura is anterior, and in tracing it to its origin, will be found to pass deeper than the origin of the portio mollis; and is separated from it by the thickness of the corpus restiforme.

The two nerves proceed together, invested in a neurilema, into the foramen auditorius internus—the portio mollis being softer than the other cerebral nerves. In proportion as it retires from the brain, the filaments become delicate, and so interwoven with each other, as to form a complicated plexus. At the under surface of the portio mollis, there is a round, white, and distinct filament, which passes to the cochlea. This filament is more compact than the others; but it is with difficulty that the fine lines, which mark its divisions into minuter filaments, are discoverable.

The portio mollis distributes itself to the labyrinth of the ear, by two rami: first, the above-mentioned to the cochlea—

(A.) *Ramus n. cochlearis.*—This enters the base of the cochlea, through a cribriform plate, at the inferior part of the bottom of the internal meatus, sometimes by a single large foramen in the centre of the modiolus, at others by three or more foramina, through which the ramus cochlearis distributes corresponding filaments, which ultimately ramify within the scalæ on the upper and under surface of the gyrus, first on its bony, and lastly on its membranous portion.

(B.) The *ramus n. vestibuli*—separates from the portio mollis within the auditory foramen, and distributes itself to the vestibule in three ramuli—a greater, a middle, and a lesser ramulus.

(*a.*) *Ramulus n. magnus*—enters the vestibule from the upper part of the meatus internus, into the anterior part of the cavity of the vestibule, and ramifies in two directions—one through a pyramidal cribriform plate of bone, which projects into the cavity of the vestibule, being distributed to the structures within the vestibule; the other passes to the outer side of the inner wall of the vestibule, and is distributed to the approximated ampullæ of the superior vertical, and horizontal semi-circular canals, in which it is lost.

(*b.*) *Ramulus n. medius*—is smaller than the preceding; it enters a separate cribriform plate below the former, in the inner wall of the vestibule, nearly opposite to the foramen ovale; it distributes itself to the cavity of the vestibule.

(*c.*) *Ramulus n. minimus*—enters a foramen in the posterior part of the internal meatus, which terminates in a cribriform plate, through which its minute filaments are distributed, partly to the ampullæ of the posterior vertical semi-circular canal, and partly to structures within the vestibule situated at the termination of the scala vestibuli.

(9.) *Glosso-pharyngeal*—arises from the tractus respiratorius of Sir Charles Bell, by three or four fine filaments, immediately beneath the facial, and above the pneumogastric nerve; from the latter of which it is separated by a small portion of the pia mater of the fourth ventricle. These filaments unite and form a nervous cord, which is directed outwards, towards the anterior part of the foramen lacerum basis cranii, through which it passes in front of the pneumo-gastric nerve—separated from it by a distinct foramen, formed of the dura mater. As soon as it has passed out of the skull, it is placed to the inner side; as well as anterior to the pneumo-gastric nerve, and internal jugular vein; and sends off—

(A.) *Ramus n. anastomoticus*—which penetrates the tympanum by a canal placed by the side of the stylo-mastoid foramen, passes to the promontory, and unites with filaments of the videan nerve, and sympathetic filaments from the carotid canal. It next sends—

(B.) *Rami n. communicantes*—to the par vagum and facial nerves, and receives filaments from the sympathetic.

The glosso-pharyngeal nerve then crosses between the external and internal carotid arteries, where it sends off two slender rami to be connected with the pharyngeal branch of the par vagum, and assists in forming the pharyngeal plexus—uniting in the course of the internal carotid artery, with filaments from the cardiac branches of the sympathetic nerve.

It next sends off filaments to the stylo-pharyngeus muscle, and then immediately two considerable rami, which are separated opposite to the styloid process of the temporal bone, they take their course inwards, and backwards, to the superior and middle constrictors of the pharynx, on which they are distributed — supplying also the tonsil, and mucous membrane of the pharynx. These branches, as well as those which go to the glosso-pharyngeus muscle, assist in forming the pharyngeal plexus, and may all be termed the *rami pharyngei.*

The glosso-pharyngeal nerve continues its course along the stylo-pharyngeus muscle, until it reaches the pharynx; and then passing between the stylo-glossus, and hyo-glossus muscles reaches the tongue, and divides into three terminating rami.

(D.) *Ramus n. lingualis superior*—passes into the musculus lingualis, and constrictor isthmi faucicum, the mucous membrane and its follicles, and sends off—

(*a.*) *Ramulus n. tonsillaris*—which expends itself in the tonsil, furnishing it with distinct filaments.

(E.) *Ramus n. lingualis inferior*—passes into the hyo-glossus muscle, and to the mucous membrane reflected from the under surface of the base of the tongue to the epiglottis —supplying its mucous follicles.

(F.) *Ramus n. lingualis medius*—passes into the tongue beneath the hyo-glossus muscle, then is directed to the upper surface of the organ—supplying the mucous follicles and papillæ capitatæ at the base of the tongue.

The glosso-pharyngeal nerve, is placed in the tongue, above the lingual nerve, but below the ramusculus gustatorius of the third division of the fifth pair.

(10.) *Tenth pair—par vagum, or pneumo-gastric nerves.* —These nerves arise immediately beneath the glosso-pharyngeal, and above the accessory; which are all indeed having origin from the same tract of spinal marrow, and from which circumstance they might be considered as one nerve, but that they are so differently distributed as to require a separate description. The pneumo-gastric nerve, arises immediately behind the corpus olivare, between it and the corpus restiforme, by eight or ten filaments, from five to six lines in length, and which are placed close to each other, becoming immediately enveloped in a neurilema; they present great firmness, and unite to form a broad flattened cord, which is directed forwards and outwards, towards the foramen lacerum basis cranii, through which it escapes from the interior of the skull, being in its passage separated from the jugular vein by a process of bone, and from the glosso-pharyngeal nerve by a distinct process of dura mater.

The precise position of the nerves which pass out of the foramen lacerum basis cranii, with respect to the internal jugular vein is, that they are anterior and internal to the vein. Within the foramen lacerum, the pneumo-gastric nerve becomes rounded, and the filaments forming the cord frequently unite, producing a kind of plexus, or sometimes even the appearance of a ganglionic enlargement, having a greyish tint; and it is here intimately connected with the spinal accessory, glosso-pharyngeal, hypo-glossal, and some filaments from the superior cervical ganglion of the sympathetic nerve. The pneumo-gastric nerve is, as it issues from the skull, placed in front of the hypo-glossal, but as it descends towards the neck, it soon becomes posterior to it; and they are entirely separated from each other, when they have descended as low as the transverse process of the atlas.

The par vagum then continues its course down the fore and lateral part of the neck, lying on the rectus capitus anticus major, and on the longus colli muscles, taking the same direction as the sympathetic nerve, but is separated from it by being enclosed in the carotid sheath, in which it is placed on the outer side of the carotid artery, between it and the internal jugular vein. The nerve next leaves the cervical region, and penetrates the chest by passing through its upper opening, behind the subclavian veins, on the right side in front of the subclavian artery, and on the left side before the arch of the aorta. When it has gained the thorax, it passes backwards, behind the bronchi; but soon leaves them, and passes forwards again towards the œsophagus, along which it passes, through the diaphragm, to supply the stomach, where it terminates. While the pneumo-gastric nerves are running along the œsophagus, that on the right side is placed much posterior to the left.

The rami which are sent off by the par vagum in this course, are—

(A.) *Rami n. communicantes.*—These have been already described as being sent off within the foramen lacerum basis cranii, and connecting the pneumo-gastric with the spinal accessory, the glosso-pharyngeal, the lingual, and with the sympathetic nerves.

Almost immediately after the par vagum has passed through the foramen lacerum basis cranii, and has given off its communicating branches, it sends off—

(B.) *Ramus n. pharyngeus*—which directly it is separated from the par vagum, takes its course downwards and forwards, and is connected by a small branch with the spinal accessory nerve; it then continues its course forwards, crossing behind the internal carotid artery, to which it sends ramusculi—uniting with filaments of the glosso-pharyngeal nerve; it still continues forwards, and reaching the pharynx, it divides into several filaments to supply the constrictors; and uniting with branches from the glosso-pharyngeal, the superior laryngeal ramus of the par vagum, and the superior cervical ganglion of the sympathetic nerve, they together constitute what is termed the pharyngeal plexus, from which emanate numerous filaments to supply the three constrictors of the pharynx.

(C.) *Ramus n. laryngeus superior*—is the next branch separated from the pneumo-gastric nerve; it takes its course downwards and inwards, and like the last-described branch, passes behind the internal carotid artery, and to the outer side of the superior cervical ganglion of the sympathetic, with which it is connected by two or three filaments, as well as with the hypo-glossal nerve; immediately after this junction with the sympathetic, it divides into two ramuli.

(*a.*) *Ramulus n. laryngeus externus*—which is the less important of the two, descends towards the sides of the larynx, and distributes itself entirely to the muscles connected with the larynx, as the sterno-hyoideus, sterno-thyroideus, thyro-hyoideus, crico-thyroideus, and the middle constrictor of the pharynx.

(*b.*) *Ramulus n. laryngeus internus*—directs itself inwards, and to gain the larynx passes behind the thyro-hyoideus muscle, penetrates the thyro-hyoideal ligament, and divides itself into two sets of ramusculi.

(*α.*) *Ramusculi n. superiores*—distribute themselves to the anterior surface of the epiglottis, the epiglottidean gland, and to the mucous membrane of the pharynx.

(β.) *Ramusculi n. inferiores*—are larger than the superior, and are distributed to the mucous membranes of the larynx and pharynx, and to the arytenoid glands and muscles; one branch in particular, descending to supply the crico-thyroideus muscle.

Cloquet describes, that these filaments never supply the muscles which open the larynx, but they may always be traced to those muscles, and uniting with the filaments of the recurrent laryngeal nerve.

The pneumo-gastric nerve, after it has sent off this branch, continues its course down the neck within the carotid sheath, being connected with the cervical branch of the hypo-glossal nerve, with the first pair of cervical nerves, and with the superior cervical ganglion of the sympathetic, which together distribute small, delicate, soft filaments, to the internal carotid artery.

The par vagum reaching the lower part of the neck, sends off their cardiac branches, which are differently distributed on the two sides.

(D.) *Rami n. cardiaci.*—These branches on the right side are given off from the pneumo-gastric nerve, about an inch above the sterno-clavicular articulation; they descend obliquely outwards, in front of the arteria innominata, and are lost by uniting with the cardiac plexus from the inferior cervical ganglion of the sympathetic nerve.

The cardiac ramus on the left side, is generally but one branch, which runs along the corresponding carotid artery, and gaining the arch of the aorta, spreads upon it, and supplies the upper and posterior part of the heart.

(E.) *Ramus n. laryngeus inferior, vel recurrens*—is separated from the pneumo-gastric nerve, after it has passed into the thorax, and they differ a little with respect to each other on the right and left side. The left branch is given off a little lower down than the right, and in curving, to ascend, passes behind the arch of the aorta, while the right recurrent branch passes behind the right subclavian artery; thus they gain the neck, along which they ascend behind the common carotid arteries and the inferior thyroideal ramuli a., by the sides of the trachea to the larynx, in which they terminate. In this course, the ramus n. laryngeus inferior gives off the following ramuli.

(*a.*) *Ramuli n. cardiaci*—are two or three twigs, which unite with the rami cardiaci from the pneumo-gastric nerve, and those from the inferior cervical ganglion of the sympathetic, which together form a plexus, and are distributed to the heart.

(*b.*) *Ramuli n. pulmonares*—are sent off higher up than the last-described, descend in front of the trachea, and taking the course of the corresponding pulmonary arteries, are lost in the lungs. The recurrent nerves, still proceeding upwards towards the larynx, supply in their course the œsophagus, the mucous membranes of the trachea, and the thyroid gland; and when they arrive at the larynx, they divide into several filaments to supply the inferior constrictor of the pharynx, and its mucous membrane; and others, which are distributed to the crico-arytenoidei postici, crico-arytenoidei laterales, and the thyro-arytenoidei muscles, as well as the mucous membrane of the larynx: these filaments form junctions with the superior laryngeal branches of the par vagum.

The pneumo-gastric nerves having given off the recurrent laryngeal rami, continue their course within the chest, and opposite the division of the trachea into the bronchi, send off three or four rami, termed the—

(F.) *Rami n. pulmonares*—which unite with filaments from the ramus laryngeus inferior, and the inferior cervical, and superior thoracic ganglia of the sympathetic—all of which concur in forming the *pulmonary plexus;* and from it are sent off numerous ramifications, which form a kind of net-work behind the roots of each lung, and distribute delicate filaments to the mucous membrane and follicles of the bronchi.

Below the pulmonary plexus, the filaments of the pneumogastric nerve re-unite and form again distinct cords, which descend along the œsophagus. The one on the right side is formed of three or four filaments, which are sent off from the lower part of the pulmonary plexus; and before they ultimately unite, form on the right side, and posterior surface of the œsophagus, an intricate plexus, and then produce a single cord. On the left side, the œsophageal rami issue from the left pulmonary plexus, and proceed upon the anterior surface and left side of the œsophagus, at first being composed of two or three branches, which, as on the right side, ultimately unite; both are distributed to the œsophagus, and also send filaments to the aorta. They then issue from the thorax, and enter the abdomen by the same opening as the œsophagus, along which they continue to pass, the right still remaining posterior, and the left anterior to that organ; and when they reach the stomach, they both divide into numerous rami.

(H.) *Rami n. ventriculares*—which from the right nerve, pass to supply the posterior surface of the stomach, and penetrate its parietes, taking the course of the great curvature of the stomach, and terminate by being connected with the solar plexus of nerves, and assisting in forming the hepatic, splenic, and cæliac ganglia.

From the left, the ventricular rami take a longitudinal course along the less curvature of the stomach, extending as far as the pylorus, and supply by many branches, the anterior surface of the organ.

(11.) *Eleventh pair—hypo-glossal, or lingual nerves*—arise from the medulla oblongata, from the groove which separates the corpora pyramidalia, from the corpora olivaria, by several filaments which pass through the dura mater, and then unite to form a cord, which passes out of the cranium through the foramen condyloideum anticum. Immediately this nerve has passed through the anterior condyloid foramen, it becomes connected with the pneumo-gastric nerve, and then taking its course downwards, and forwards, passes over the external and internal carotid arteries, pneumo-gastric, and sympathetic nerves, and under the digastric and stylo-hyoides muscles, and the internal jugular vein; it unites with the arch formed by the junction of the suboccipital and first pair of cervical nerves. It then passes forwards towards the angle of the jaw, takes its course along the under edge of the tendon of the digastricus muscle, and then rises upwards towards the tongue. Just where the lingual nerve forms its curve around the digastric muscle, it frequently receives a filament from the pneumo-gastric nerve, and immediately sends off the—

(A.) *Ramus n. cervicalis descendens.*—This branch descends along the inner side of the internal jugular vein, taking its course downwards, in the direction of the pneumo-gastric nerve, to about the middle of the neck, sending off two ramuli—

(*a.*) *Ramuli n. musculares*—which supply the omo-hyoideus and sterno-thyroideus muscles, and then is reflected backwards and upwards to unite behind the sterno-cleido mastoideus, with a descending branch from the second and third pair of the cervical nerves, forming an arch, from the convexity of which filaments are distributed, some passing forwards to supply the thyro-hyoideus, some downwards to the omo-hyoideus, and others outwards to the posterior edge of the sterno-cleido mastoideus, where they anastomose with filaments of the third, and fourth cervical nerves.

(*b.*) *Ramulus n. lingualis*—is really the continuation of the nervous trunk, and takes its course forwards and upwards, passing between the venous rami of the internal jugular, and the external carotid ramulus; accompanying its corresponding artery between the mylo-hyoideus and hyo-glossus muscles, until it reaches the outer or posterior edge of the hyo-glossus; and then the arterial branch leaves the nerve by passing upon its upper or mucous surface; while between the mylo-hyoideus, and hyo-glossus muscles, the ramulus lingualis gives off—

(*α.*) *Ramusculi n. musculares*—to supply the thyro-hyoideus, constrictor pharyngeus superior, stylo-pharyngeus, genio-hyoideus, mylo-hyoideus, and genio-glossus muscles: it is also connected with the superior cervical ganglion of the sympathetic, and with the mylo-hyoideal filaments of the ramusculus dentalis n. inferior. Upon the inferior, or cutaneous surface of the hyo-glossus muscle, several junctions take place, between the gustatory branch of the third division of the fifth pair, and this lingual ramulus; which, upon arriving at the anterior edge of the hyo-glossus, again meets its corresponding arterial ramulus, and they together pass between the genio-glossus, and lingualis muscles, and then passing forwards and inwards, the ramulus n. lingualis is lost by being distributed to the muscles of the tongue.

LECTURE XXXIV.

DESCRIPTIVE ANATOMY OF THE SPINAL NERVES.

The spinal nerves consist of thirty-two pair, on either side arising from the sides of the medulla spinalis, and are named numerically, commencing from above, as first pair, second, third, and so on. There are two pair, however, which differ from the remainder of the spinal nerves; namely, the accessory—peculiar in arising from the spinal marrow low in the cervical region, passing into the cranium and then out again through the foramen lacerum basis cranii; and the sub-occipital—which takes origin from the spinal marrow, between the foramen magnum and the atlas. These two nerves, therefore, are usually described separately, and are not classed with the other spinal nerves; although the accessory only, does not correspond with the rest of the spinal nerves, in arising from the anterior and posterior pillars of the medulla spinalis by distinct roots.

(1.) *Nervus accessorius Willisii*—arises from the posterior part of the lateral surface of the spinal marrow, from the tractus respiratorius of Sir Charles Bell, by several filaments, which are placed between the posterior roots of the cervical nerves, and the ligamenta denticulata. It usually arises opposite to the fourth cervical nerve, but sometimes as low down as the sixth, or even the seventh. As the accessory nerve ascends, it increases in size, from the additional filaments which it receives, and enters the skull through the foramen magnum, posterior to the vertebral artery; in this passage not uniting with the sub-occipital nerve. Having entered the foramen magnum, it is directed outwards, and a little forwards, to gain the foramen lacerum basis cranii, beneath the pneumo-gastric nerve, but enclosed in the same sheath, and firmly connected with it. On leaving the skull, in its passage through the laccrated foramen it becomes connected with the hypo-glossus nerve, then leaves it, passes outwards behind the internal jugular vein to gain the sterno-cleido mastoideus muscle, which it penetrates, and terminates by distributing branches to the trapezius muscle. In this course, it sends off the following rami.

(A.) *Ramus n. communicans.*—This branch is sent off from the accessory, while enclosed within the same sheath with the pneumo-gastric nerve, to which it passes, hence it is named the accessory nerve to the par vagum, which is enlarged in consequence of this addition.

(B.) *Ramus n. pharyngeus accessorius*—is a small branch generally divided into one or two filaments, which become immediately connected with the ramus pharyngeus of the par vagum, as well as some filaments of the superior cervical ganglion of the sympathetic, these together forming the pharyngeal plexus. This branch then continues beneath the ramus laryngeus superior, and divides into several filaments, producing a plexiform appearance by its frequent connection with the pneumo-gastric nerve.

(2.) *Nervi sub-occipitales*—arise from the spinal marrow immediately below the medulla oblongata, between the occiput and the atlas; like all the other spinal nerves each nerve arises by anterior and posterior filaments, the latter forming a ganglion; the two roots of the nerve converge, pass outwards and backwards to perforate the fibrous canal, by which the vertebral artery enters the skull; and then the two roots unite to form one nerve, from which there emanate two rami.

(A.) *Ramus n. anterior*—is small, directs itself from behind forwards, over the transverse processes of the atlas, in front of which it descends to be united with the first pair of cervical nerves, producing an arch which embraces the transverse process of the atlas. The ramus anterior, in its course sends off—

(*a.*) *Ramuli n. musculares*—which divide themselves into several small ramusculi, to supply the rectus capitis lateralis, rectus capitis anterior minor muscles, and also send off communicating ramusculi to the superior cervical ganglion of the sympathetic, pneumo-gastric, and hypo-glossal nerves.

(B.) *Ramus n. posterior*—is larger, but shorter than the ramus anterior; it takes its course upwards, and backwards, towards a space between the obliqui, and rectus capitis posticus major muscles, having gained which it divides into three ramuli.

(*a.*) *Ramulus n. occipitalis superior et internus.*—This ramulus is directed upwards and inwards, between the complexus and the rectus capitis posticus major, and minor muscles, to each of which it distributes filaments.

(*b.*) *Ramulus n. occipitalis superior, et externus*—passes outwards, and is lost upon the obliquus capitis superior muscle.

(*c.*) *Ramulus n. occipitalis inferior, vel cervicalis*—descends towards the obliquus inferior muscle, to which it distributes branches; and then dividing into filaments, it unites with the posterior branch of the first cervical nerve, and sends a few filaments to the complexus muscle. The sub-occipital nerve, is described by some anatomists as the first pair of cervical; but as it does not reach the spinal foramen of the cervical vertebræ, it appears more adviseable to describe it separate from the cervical nerves.

Nervi Cervicales.

The cervical nerves consist of seven pairs, of which the following general description may be first given. They are all sent off from the spinal marrow, arising by two distinct roots; they pass out of the vertebral foramina, bounded posteriorly, by the scalenus medius muscle; and anteriorly, the three upper are bounded by the rectus capitis anticus major, and the four lower, by the longus colli muscle.

The three superior pairs are all alike in being connected with each other, with the superior and middle cervical ganglia of the sympathetic, with the pneumo-gastric, and hypo-glossal nerves, as well as in supplying the exterior of the back of the head, and the neck.

The three lower pairs all unite with each other, and with the first dorsal pair, to form the axillary plexus; while the fourth or middle cervical pair, assist both the upper and the lower set in performing their particular functions. Besides this description, each of the cervical nerves sends off some rami peculiar to itself, requiring therefore a separate, and particular description.

(3.) *Nervi cervicales primi*—pass out of the spinal canal, between the atlas and vertebra dentata, and divide into an anterior and posterior ramus.

(A.) *Ramus n. anterior*—passes forwards between the transverse processes of the first two vertebræ, and divides into—

(*a.*) *Ramulus n. ascendens*—which sub-divides into two or three ramusculi, one of which unites with the sub-occipital nerve, another with the superior cervical ganglion of the sympathetic, a third with the pneumo-gastric; and it terminates by sending some small branches to the rectus capitis anticus major muscle.

(*b.*) *Ramulus n. descendens*—passes downwards to be connected with the second pair of cervical nerves.

(B.) *Ramus n. posterior, vel occipitalis magnus*—is a larger branch than the anterior, from which circumstance it differs from all the other cervical nerves. At its commencement it unites, above, with the sub-occipital nerve, and below, with the posterior branch of the second cervical pair; it then continues its course, passing from below upwards and backwards, on the inferior oblique muscle, ascending between it and the complexus muscle, which it traverses; becoming then subcutaneous, it divides into numerous ramuli.

(*a.*) *Ramuli n. musculares*—these supply the complexus, trachelo-mastoideus, splenius, and trapezius muscles, and terminate at the back of the head, in filaments, which expand upon the occipital muscles and the integuments; uniting with filaments of the sub-occipital, and facial nerves.

(4.) *Nervi cervicales secundi*—pass out between the second and third cervical vertebræ, are larger than the preceding, and like them, divide into an anterior, and posterior ramus.

(A.) *Ramus n. anterior*—passes forwards and outwards, and subdivides into—

(*a.*) *Ramulus n. ascendens*—which unites with the first pair, and

(*b.*) *Ramulus n. descendens*—to unite with the third pair of cervical nerves; it receives also a filament from the superior cervical ganglion, and a second from the sympathetic nerve itself, in its course downwards towards the middle cervical ganglion; each filament concurring in forming the cervical plexus. The ramulus descendens then terminates by supplying the rectus capitis anticus major, and the levator anguli scapulæ muscles.

(B.) *Ramus n. posterior*—is smaller than the anterior branch, is directed backwards, around the articulation between the second and third cervical vertebræ, and becomes subcutaneous at the upper part of the neck. It sends a filament to unite with the posterior branch of the first pair, and then divides into a number of ramuli, which distribute themselves to the recti and oblique muscles of the head, to the cervical, inter-spinous muscles, trachelo mastoideus, splenius, and transversalis muscle, and terminates by ramifying on the integuments of the back part of the head and neck.

(5.) *Nervi cervicales tertii*—emanate from the spinal marrow, between the third and fourth cervical vertebræ; they are smaller than the last pair, and each divides into an anterior and a posterior branch.

(A.) *Ramus n. anterior* — passes forwards, and sends a ramulus upwards to unite with the second pair, and a ramulus downwards to unite with the fourth pair; it also receives a filament from the superior cervical ganglion of the sympathetic; all uniting to form the cervical plexus.

(B.) *Ramus n. posterior*—is placed in a groove formed between the articular processes of the third and fourth cervical vertebræ, from which it emanates, and descends between the complexus and semi-spinalis colli muscles, to both of which it sends filaments, and is ultimately lost upon the skin of the back.

The *plexus cervicalis.*—It has already been described, that the anterior branches of the first, second, and third pair of cervical nerves, after receiving filaments from the superior cervical ganglion of the sympathetic, unite with each other, forming arches, which send off branches that again unite, producing the cervical plexus.

This plexus is situated on the sides of the neck, in the space between the second, third, and fourth vertebræ. It is bounded on the inner side by the scalenus medius, the pneumo-gastric nerve, the carotid artery, and the jugular vein; and outwards, by the sterno-cleido mastoideus; it communicates above with the sub-occipital nerves, below, with the brachial plexus, inwards, with the ganglia of the sympathetic—furnishing also branches of connection with the spinal accessory nerve; and terminating by numerous rami, which may be classified into ascending and descending branches.

(A.) *Ramus n. descendens internus*—arises by two filaments from the second and third pair of cervical nerves, and unites to form a single cord, which descends behind the sterno-cleido mastoideus, and in the middle of the neck unites with the ramus n. cervicalis descendens of the hypo-glossal nerve, forming loops or arches upon the inner side of the sterno-cleido mastoideus.

(B.) *Ramus n. diaphragmaticus, vel phrenicus.*—This branch, as well as the former, is frequently described as distinctly arising from the cervical nerves themselves; but evidently they spring from the plexus. The filaments, however, which form it, may be traced principally to the anterior branch of the third pair of cervical nerves; also some may be traced to the fourth, and to the second pairs. It then descends along the side of the neck, receiving filaments from the brachial plexus at the lower part of the neck, and uniting with the descending cervical branch of the hypoglossal nerve, and the superior cervical ganglion of the sympathetic. In its passage down upon the neck, it is placed between the rectus capitis anticus major, and scalenus anticus muscles, upon the latter of which it becomes placed more inferiorly—communicating here with the inferior cervical ganglion of the sympathetic by one or two filaments; it then penetrates the chest, in front of the subclavian arterial ramus, and behind the corresponding vein. It is then found in the middle mediastinum, between the pleura and the pericardium, descending towards the diaphragm.

The phrenic nerve of the right side, which is placed more vertically and anteriorly than the left, divides before entering the diaphragm, into six or seven ramuli; some of which are distributed to that muscle, and others pass through it, accompanying the corresponding arterial and venous ramuli, to supply the under surface of the diaphragm, and unite with the cæliac plexus of the pneumo-gastric nerve. The left phrenic nerve is posterior to the preceding, is more oblique in its course, being turned to the left by the apex of the heart; it is distributed to the two surfaces of the diaphragm, and sends some filaments to the œsophagus, and ultimately unites with the solar, and cæliac plexus.

(c.) *Rami n. descendentes externi*—arise principally from the third and fourth pairs of cervical nerves, by filaments which produce numerous ramuli, which afterwards subdivide, and are named according to the direction which they take.

(*a.*) *Ramuli n. supra-claviculares*—these descend under the platysma myoides muscle, divide into a number of filaments, some of which pass in front of the clavicle to be distributed to the pectoralis major muscle, the integuments of the thorax, and to the mammæ, while others pass more outwards, and are lost upon the skin, and muscles of the shoulder.

(*b.*) *Ramuli n. supra-acròmiales*—take their course along the upper edge of the trapezius muscle, which they in part supply, and unite with filaments of the spinal accessory nerve, terminating in filaments which are lost in the upper part of the acromion.

(*c.*) *Ramuli n. sub-claviculares*—pass deeply seated in the cellular membrane, between the sterno-cleido mastoideus and the trapezius, then pass behind the clavicle to be distributed to the omo hyoideus, serratus magnus, and subscapularis muscles, and cellular membrane within the axilla.

(*d.*) *Ramuli n. cervicales profundi*—pass downwards, backwards, and outwards, accompanying and uniting with the descending branches of the spinal accessory nerve, to be distributed to the trapezius, levator scapulæ, and rhomboidei muscles.

The first of the ascending branches from the cervical plexus, is—

(*a.*) *Ramulus n. superficialis colli*—arises principally from those filaments of the cervical plexus, which proceed from the second pair of cervical nerves; it bends around the posterior edge of the sterno-cleido mastoideus, and divides into numerous ramuli—many of which terminate upon the skin, side of the neck, and the lower jaw—uniting with filaments of the facial nerve.

(*b.*) *Ramulus n. auricularis*—sometimes arises from the preceding ramulus, at others separately from the cervical plexus; it is directed upwards to the anterior edge of the sterno-cleido mastoideus, along which it ascends to the angle of the lower jaw, where it divides into several ramusculi, the anterior of which ascend upon the outer surface of the parotid gland, uniting with the facial nerve, and are lost in the integuments of the ear; while the posterior ramusculi take their course upwards, upon the mastoid process of the temporal bone, expand themselves upon the ear, and the integuments covering the meatus auditorius externus, and the sides of the head.

(*c.*) *Ramulus n. occipitalis minor*—usually arises separately from the cervical plexus, passes upwards over the splenius and trachelo mastoideus muscles, towards the mastoid process of the temporal bone, where it divides into numerous filaments to be distributed to the occiput and back part of the ear, and to unite with the facial, and posterior branch of the second cervical nerves.

(6.) *Nervi cervicales quarti.*—This pair of nerves has already been described as forming the phrenic nerve and the cervical plexus; but it is also united with the—

Fifth, sixth, and seventh pairs, to form the *axillary plexus.*

The *anterior branches* of these nerves are very large, and pass out upon the lateral region of the neck, between the scalenus medius and scalenus anticus muscles, where they furnish one or two small filaments, which unite with the middle and inferior cervical ganglia of the sympathetic nerve; they then all unite to produce the axillary plexus.

The anterior branch of the fourth pair of cervical nerves, unites above with the third pair; and the anterior branch of the seventh, below, with the first pair of dorsal nerves.

The *posterior branches* of the fourth, fifth, sixth and seventh pairs of cervical nerves, are much smaller than the anterior, and pass obliquely outwards, between the semispinalis colli and complexus muscles, supplying them with filaments, as well as the splenius and trapezius muscles, and are then lost upon the integuments, and posterior part of the back, and neck.

Plexus Axillaris.

The axillary plexus formed by the anterior branches of the nerves above named, and of the anterior branch of the first dorsal, is large above and below, and contracted in its centre, reaching from the lateral and inferior part of the neck, into the axilla. At its origin, it passes out between the two scaleni muscles, is directed downwards, between the subclavius muscle and the first rib, rests upon the serratus magnus muscle, surrounding the subclavian artery and the vein, and then divides into numerous branches. This plexus may be divided into thirds ; the superior of which is above and to the outer side of the subclavian artery, the middle completely surrounding it, and the inferior third divides into numerous branches, which are placed in a regular order on either side of the vessel. The branches given off from the axillary plexus, are—

(A.) *Rami n. thoracici.*—The filaments forming these nerves, are sent off principally from the cervical nerves, between the fourth and sixth, and are given off from the anterior and posterior parts of the plexus, so as to be distinctly divided into an anterior and posterior ramulus.

(*a.*) *Ramulus n. anterior.*—The filaments which form this ramulus, are derived from the sixth pair of cervical nerves, and unite in a cord, which passes behind the clavicle, where it divides into numerous ramusculi, which pass in front of the axillary artery, and in part surround it. The ramusculi then descend upon the thorax, and are distributed to the pectorales muscles.

(*b.*) *Ramulus n. posterior*—is principally derived from the fourth and fifth pairs of cervical nerves. It descends upon the parietes of the chest, to be distributed to the serratus magnus muscle ; at the lower part of which it divides into numerous ramusculi.

(B.) *Ramus n. suprascapularis*—springs principally from the fourth pair of cervical nerves ; usually, however, deriving a small filament from the fifth pair. It descends obliquely backwards, behind the trapezius muscle, accompanying the ramulus a. supra-scapularis, towards the superior part of the shoulder, where it reaches the proper notch of the scapula ; and here it separates from the arterial ramulus to pass through the foramen under the ligament, while the artery passes over it. The first ramusculus which this ramus gives off, supplies the subscapularis muscle. It afterwards furnishes numerous filaments, which are lost upon the supra and infra spinati muscles, and the teres minor.

(C.) *Rami n. infra-scapulares*—these are so variable in number, origin, and distribution, as generally not to be described as distinct branches; but still from their size are sufficiently important. Most frequently, they are three in number; the first passes to supply the serratus magnus, and the subscapularis muscles, and is ultimately lost upon the latissimus dorsi; this ramus passes behind the axillary artery, to gain the muscles which it supplies: the second branch, is lost entirely in the subscapularis muscle: while the third passes downwards and backwards, along the anterior edge of the subscapularis muscle, and is lost in the terretes.

(D.) *Ramus n. articularis, vel circumflexus*—arises from filaments of the sixth and seventh cervical, and first pair of dorsal nerves; it descends in front of the subscapularis muscle, to which it distributes a ramulus; it then takes its course from before backwards, between the terretes muscles and the long head of the triceps, and gains the posterior and superior part of the humerus, sending some small filaments to those muscles; it continues its course from within outwards, gains the posterior edge of the deltoid muscle, passes between it and the humerus, and terminates by supplying the posterior part of the deltoid, and the capsular ligament of the shoulder-joint.

(E.) *Ramus n. cutaneus internus*—arises by small filaments, from the last cervical, and first dorsal pair of nerves. It descends vertically along the inner side of the arm, taking the course of the ramus venosus basilicus, distributing unimportant filaments to the skin in its descent; but just before it arrives at the inner condyle of the humerus, it divides into two ramuli.

(*a.*) *Ramulus n. externus*—is the smaller of the two, takes its course along the biceps muscle, penetrates the brachial aponeurosis to accompany the median nerve to the bend of the elbow; where it again becomes sub-cutaneous, and divides into several filaments, some of which descend with the integuments as low as the wrist.

(*b.*) *Ramulus n. internus*—descends upon the brachialis internus muscle, and just at the inner condyle divides into an anterior and posterior ramusculus, which supply the skin on the anterior and posterior side of the fore arm, as low as the wrist-joint, taking the course of and surrounding the subcutaneous veins on the inner side of the arm.

(F.) *Ramus n. cutaneus internus minor*—is by some anatomists described as a branch of the ulnar nerve, but it may generally be traced distinctly from the axillary plexus itself; it is much smaller than the last-described nerve, and is partly lost upon the triceps muscle; but some of its filaments pass through the brachial aponeurosis, become subcutaneous, and are lost upon the skin on the inner side of the arm and axilla.

(G.) *Ramus n. cutaneus externus, vel musculo-cutaneus*—arises from the fourth and fifth pair of cervical nerves. It is larger than the last-described, and takes its course downwards and outwards, perforating the coraco-brachialis muscle, to which it distributes filaments; it then descends between the brachialis internus, and the biceps muscles, distributing filaments to each of them, and uniting with the median nerve; it continues its course along the outer side of the tendon of the biceps, between it and the superior radii longus, passes through the bend of the elbow, crossing behind the median cephalic vein; it then descends along the fore and outer part of the arm, between the aponeurosis and the skin, and just before it reaches the wrist-joint, it divides into an outer, and an inner ramulus.

(*a.*) *Ramulus n. posterior*—is the larger of the two, passes outwards to the back of the hand, and sends a branch which passes to the fingers; it then descends behind the thumb, sending a filament to its radial side, and also to the fore finger.

(*b.*) *Ramulus n. anterior*—continues in the course of the principal ramus to the palm of the hand, divides into numerous ramusculi to supply the muscles of the thumb and skin, covering them and the palm of the hand.

(H.) *Ramus n. medianus*—is the largest of all the nerves from the axillary plexus; it arises by filaments from all the cervical, and first pair of dorsal nerves; its origin is placed behind the internal cutaneus, and between the ulnar and external cutaneous nerves. These filaments unite into a nervous cord, which descends outwards, behind the biceps and on the inner side of the brachial artery; it continues its course with the artery through the bend of the elbow, on the inner side of the biceps, and passes between the two origins of the pronator radii teres; it then proceeds along the fore-arm, lying upon the flexor profundus digitorum, and being covered by the flexor sublimis; as it gains the wrist, the median nerve passes immediately behind the tendon of the palmaris longus muscle, and continuing under the ligamentum carpi annulare, gains the palm of the hand, where it divides into numerous digital ramuli. But in this course, it first gives off—

(*a.*) *Ramuli n. musculares*—which are distributed to the pronator radii teres, flexor carpi radialis, palmaris longus, flexor carpi ulnaris, the flexor digitorum sublimis et profundus, and the flexor longus pollicis. Almost immediately after, the median nerve sends off—

(*b.*) *Ramulus n. interosseus.*—This ramulus passes backwards between the flexor muscles of the fingers, to gain the anterior surface of the interosseous ligament; in its passage between the flexor muscles, it sends a ramusculus to the flexor sublimus digitorum; and secondly, ramusculi to the flexor profundus digitorum, and the flexor tertii internodii pollicis; it then accompanies the ramusculus arteriosus interosseus anterior, as far as the upper edge of the pronator quadratus muscle, where it divides into two sets of filaments, —the anterior of which are lost upon the anterior part of the wrist-joint, behind the pronator quadratus muscle; while the posterior penetrate the interosseous ligament, and are lost upon the back of the hand.

The ramus n. medianus—after having sent off the ramulus interosseus, continues its course downwards on the fore-arm, sending off muscular ramuli to the flexors of the fingers and wrist, forming also unions with the ulnar nerve; and about two inches above the ligamentum carpi annulare, it sends off—

(*c.*) *Ramulus n. palmaris cutaneus*—which is distributed, as its name would imply, to the skin of the palm of the hand, by passing between the tendons of the flexor sublimis, and thus becomes sub-cutaneous.

The ramus medianus having gained the hand, almost immediately divides itself into four or five distinct ramuli, which are ultimately distributed to the fingers; supplying, however, at the same time, the short muscles of the palm of the hand.

(*d.*) *Ramulus n. digitalis primus*—sends several filaments to the abductor, flexor primi, et secundi, internodii pollicis, and descends along the radial side of the thumb, as far as its extremity, accompanying the corresponding arterial ramification.

(*e.*) *Ramulus n. digitalis secundus*—descends upon the ulnar side of the thumb, and sends off numerous branches to supply the muscles and skin.

(*f.*) *Ramulus n. digitalis tertius*—descends upon the radial side of the metacarpal bone of the fore finger, sends a filament to the first lumbricalis muscle, and ultimately terminates by supplying the skin of the radial side of the fore finger.

(*g.*) *Ramulus n. digitalis quartus*—descends between the metacarpal bones of the fore and middle fingers, supplies the lumbricalis muscle in that situation, and at the anterior extremity of the metacarpal bone, it divides into two ramusculi, to supply the ulnar side of the fore, and the radial side of the middle finger.

(*h.*) *Ramulus n. digitalis quintus*—takes its course between the metacarpal bones of the middle and ring fingers, supplies the corresponding lumbricalis muscle, divides into two ramusculi, which expend themselves upon the ulnar side of the middle finger, and the radial side of the little finger. The latter ramusculus unites with the digital ramusculus of the ramus nervosus ulnaris.

(I.) *Ramus n. ulnaris, vel cubitalis*—is somewhat smaller than the last branch, and is given off from the sixth and seventh cervical, and first dorsal pair of nerves; it takes its course downwards upon the inner side of the arm, resting upon the triceps extensor cubiti muscle, and in this course sends ramuli to it, as well as to the skin. It then passes behind the internal condyle, between it and the olecranon process of the ulna, and usually between the two origins of the flexor carpi ulnaris, where it sends off a cutaneous branch which takes the course of the superficial ulnar veins; it then gains the fore-arm, passes obliquely downwards and forwards, on its inner side, between the flexor carpi ulnaris and flexor digitorum profundus, and to the ulnar side of its corresponding arterial ramus. It diminishes in size as it descends, and divides just before it reaches the wrist-joint, into two ramuli; previous to which, it furnishes muscular ramuli, especially to the flexor carpi ulnaris, and flexor profundus digitorum.

(*a.*) *Ramulus n. palmaris*—takes its course along the radial side of the flexor carpi ulnaris, passes upon the same side of the pisiform bone, upon the anterior surface of the ligamentum carpi annulare, where it is connected with some of the filaments of the median nerve, and then divides into two ramusculi.

(*α.*) *Ramusculus n. profundus*—takes its course backwards, between the abductor and flexor brevis minimi digiti; it is then directed outwards, behind the tendons of the flexors of the fingers and the lumbricales, where it forms an arch furnishing filaments from its convexity, to supply the muscles of the little finger, and the interossii, as well as the adductor muscle of the thumb, and abductor of the index finger.

(*β.*) *Ramusculus n. superficialis*—is connected by one or two twigs, to filaments of the ramus n. medianus; it also distributes filaments to the muscles of the little finger, and then divides into an outer and an inner ramification; the outer unites with the median nerve, supplies the fourth lumbricalis muscle, and terminates by two digital filaments which supply the ulnar side of the ring finger, and the radial side of the little finger; while the inner ramification, which is the smaller of the two, supplies the abductor minimi digiti, and is lost upon the ulnar side of the little finger.

(*b.*) *Ramulus n. dorsalis*—has already been described, as being separated from the ramus n. ulnaris above the wrist-joint; it is smaller than the palmar branch, and passes backwards, between the ulnar and the tendon of the flexor carpi ulnaris, to gain the back of the hand, where it divides into two ramusculi.

(*α.*) *Ramusculus n. internus*—descends along the ulnar side of the metacarpal bone and phalanges of the little finger, and is distributed to the skin upon their posterior surfaces.

(*β.*) *Ramusculus n. externus*—passes between the metacarpal bone of the ring, and middle fingers, and divides into two digital filaments, to be distributed to the radial side of the posterior surface of the middle finger, and ulnar side of the ring finger.

(K.) *Ramus n. radialis, vel spiralis*—arises principally from the sixth and seventh cervical, and first dorsal pair of nerves; but filaments may generally be traced connected with all the nerves which enter into the composition of the axillary plexus; immediately after these filaments have united to form one ramus, it passes downwards and backwards, taking its course outwards in a spiral direction, between the humerus and the first and second heads of the triceps: and having gained the outer side of the arm, it descends between the brachialis internus, and extensores carpi radiales, to gain the elbow-joint, being placed posterior to the ramus n. cutaneus externus; and here it divides into two ramuli. In its course from its origin to the elbow, and before it divides into its two terminating ramuli, it first gives off—

(*a.*) *Ramuli n. musculares*—which supply the latissimus dorsi, and triceps muscles.

(*b.*) *Ramulus n. cutaneus posterior*—which pierces the brachial aponeurosis, and supplies the skin of the posterior parts of the arm and fore-arm; just before it divides, it sends off several filaments to supply the muscles about the elbow-joint, and usually a cutaneous filament, which supplies the skin on the outer side of the fore-arm.

(*c.*) *Ramulus n. anterior, vel superficialis*—descends into the fore-arm, along the ulnar side of the supinator radii longus, and on the radial side of the ramus arteriosus radialis; in the lower third of the fore-arm, it is directed outwards, passing between the radius, and tendon of the supinator radii longus, to gain the posterior surface of the bone, upon which it descends, lying superficial to the tendons of the extensors of the thumb, and then divides into two ramusculi.

(*α.*) *Ramusculus n. externus*—passes on the dorsal surface of the thumb, divides into two filaments, the outer of which is distributed to both sides of the thumb, and radial side of the fore finger; while—

(*β.*) *Ramusculus n. internus*—passes over the back of the hand, and is distributed upon the inner side of the dorsal surface of the index, and radial side of the middle finger.

(*d.*) *Ramulus n. posterior*—is separated from the ramus n. radialis, behind the supinator radii longus, to which it sends filaments, as well as to the extensores carpi radiales, and to the anconeus muscles. The ramulus n. posterior then perforates the supinator radii brevis muscle, to which it sends filaments; it then winds around the upper part of the radius, to gain the posterior part of the arm, and there divides into numerous ramusculi, which take an anterior and a posterior direction.

(*α.*) *Ramusculi n. posteriores*—are distributed to the extensor carpi ulnaris, the extensor longus digitorum, and the extensor indicis muscles; while—

(*β.*) *Ramusculi n. anteriores*—pass forwards to be distributed to the muscles deeply seated between the radius and ulna behind. One ramusculus in particular, descends along the interosseous ligament, behind the ligamentum carpi annulare dorsale, to be distributed on the back of the hand.

Nervi Dorsales.

These nerves consist of twelve pairs, and are comparatively smaller than the cervical nerves. They are named according to their succession, beginning from above; they arise, like the cervical nerves, by anterior and posterior roots from the anterior and posterior columns of the spinal marrow; and like them, unite into a single nerve as soon as they have emerged from the intervertebral foramen. The first pair pass out between the first two vertebræ of the back, the last pair, between the last vertebra of the back and the first of the loins.

(A.) The *rami n. posteriores*—of all the dorsal nerves, are so alike in their distribution, as to admit of a general description. They pass backwards, between the transverse processes of the dorsal vertebræ, under the semi-spinalis dorsi, and multifidi spinæ; and then divide into two sets of ramuli.

(*a.*) *Ramuli n. interni*—pass backwards and inwards, through the spinalis dorsi, and multifidi spinæ muscles, imparting filaments to them, as well as to all the muscles of the back, and are lost in supplying the skin.

(*b.*) *Ramuli n. externi*—are the larger, and pass outwards, beneath the deep layer of the muscles of the back, and become superficial after passing between the sacro-lumbalis and latissimus dorsi, to which they send ramusculi, and are ultimately lost in the skin of the back and side.

(B.) *Rami n. anteriores*—each of these receives a filament from the thoracic ganglia of the sympathetic nerve; then they pass outwards behind the pleura and between the ribs, as far as the angle of those bones, when they enter between the external and the internal layer of intercostal muscles, passing with such an obliquity upwards, as to gain the inferior edge of the rib above them; in which course, they are accompanied by the arteriæ intercostales.

The above general description refers to the whole of the dorsal nerves; but it will be now necessary to take a more particular view of the distribution of the anterior branch of each pair.

(10.) *Nervi dorsales primi.*

(B.) *Ramus n. anterior.*—One ramulus of this ramus has already been mentioned, as concurring in the formation of the axillary plexus; but it also sends off—

(*b.*) *Ramulus n. descendens*—which proceeds under the inferior surface of the first rib, passing inwards towards the sternum, perforates the intercostal muscles, and is lost upon the upper part of the chest.

(11.) *Nervi dorsales secundi.*

(B.) *Ramus n. anterior*—takes its course along the inner surface of the second rib, giving filaments to the intercostal, and the serratus magnus muscles, and then divides into—

(*a.*) *Ramulus n. intercostalis*—which continues to run along the lower edge of the rib, as far as the sternum, where it penetrates the external intercostal muscle, and is lost upon the chest.

(*b.*) *Ramulus n. brachialis*—perforates the external intercostal muscle, passes through the axilla, descends along the internal and posterior part of the arm, and near the elbow is lost by supplying the skin; uniting in its course with ramifications of the internal cutaneous nerve.

(12.) *Nervi dorsales tertii.*

(B.) *Ramus n. anterior.*—This ramus is distributed in a similar manner to the last, by being divided into two ramuli.

(*a.*) *Ramulus n. intercostalis*—takes the course of the rib; passes forwards to the sternum, supplies the intercostalis, and triangularis sterni muscles, perforates the external intercostal muscle, and is lost upon the anterior part of the chest.

(*b.*) *Ramulus n. brachialis*—also perforates the intercostal muscle, which it supplies, crosses the lower part of the axilla, and is lost upon the inner side of the arm.

(13 to 17.) *Nervi dorsales*—4th, 5th, 6th, 7th.

(B.) *Rami n. anteriores*—take their course along the inferior edge of their corresponding ribs, and towards the centres divide into two ramuli.

(*a.*) *Ramuli n. interni*—continue in the course of their original branches, and distribute filaments about the sternum, to the triangularis sterni, pectoralis major muscles, mammæ, and integuments of the chest.

(*b.*) *Ramuli n. externi*—perforate the intercostal muscles, and supply by numerous filaments the integuments of the side of the chest, the obliquus abdominis externus muscle, and the integuments of the abdomen.

(18 to 20.) *Nervi dorsales*—8th, 9th, 10th, 11th.

(B.) *Rami n. anteriores*—take their course, and are distributed in a similar manner to the preceding rami of the upper dorsal nerves.

(*a.*) *Ramuli n. interni*—run along the inferior edge of their corresponding ribs, and gain the parietes of the abdomen by passing over the origins of the diaphragm; and being placed between the transversalis and obliquus abdominis internus muscles, to which they distribute filaments, then arrive at the outer edge of the rectus muscle, and there divide into two sets of ramusculi.

(*α.*) *Ramusculi n. profundi*—form the posterior distribution from the above, and supply the recti muscles only.

(*β.*) *Ramusculi n. superficiales*—penetrate these muscles, and are lost upon the integuments of the anterior region of the abdomen.

(*b.*) *Ramuli n. externi*—penetrate the intercostal muscles, and divide into filaments, which are distributed to the integuments of the lateral parts of the chest, and the muscles and skin of the abdomen.

(21.) *Nervi dorsales*—12th.

(B.) *Rami n. anteriores.*—Each of these, immediately at its origin, sends off—

(*a.*) *Ramulus n. communicans*—by which it is connected with the first lumbar nerve; the anterior branch is then directed downwards and outwards, passing in front of the quadratus lumborum muscle, and behind the fascia iliaca and fascia transversalis, takes the direction of the last rib, at the anterior extremity of which it divides into two ramusculi; the most superficial one passes between the obliqui muscles of the abdomen, distributes filaments to them, and is ultimately lost on the skin; the deeper one passes between the transversalis and internal oblique muscles, and terminates at the rectus and pyramidalis muscles.

Nervi Lumbales.

These are five pairs, which arise from the inferior enlargement of the spinal marrow, by anterior and posterior branches, like all the other spinal nerves. The filaments that compose them are large and broad, especially of the three lower. These nerves are immediately enveloped in a neurilema, and pass downwards with such a degree of obliquity, and so separate from each other, as to form what has been termed the *cauda equina.* The posterior root of each of these nerves, like those of the dorsal region, form a ganglion; after which, the anterior and posterior filaments unite to produce one cord, which almost immediately divides into a posterior and an anterior branch.

(22.) *Nervi lumbales primi.*

(A.) *Ramus n. posterior*—is directed immediately backwards, between the transverse processes of the two first lumbar vertebræ, penetrates the lumbar mass of muscles, to which it distributes ramifications, and is lost by supplying the skin of the hip and gluteal region.

(B.) *Ramus n. anterior.*—This branch directly it has emerged from the intervertebral foramen, receives a branch from the lumbar ganglia of the sympathetic nerve, and also a communicating ramulus from the twelfth dorsal nerves. It then passes forwards and downwards, under the psoas muscle, unites with the second lumbar nerve, and terminates by forming the lumbar plexus.

(23 to 26.) *Nervi lumbales*—2nd, 3rd, 4th, 5th.

These four pairs of lumbar nerves, divide into anterior and posterior branches, which are distributed in a similar manner to those of the first pair, differing only in situation; and like them also, they are connected with the sympathetic nerve, and with each other; and all concur in forming the—

Plexus Lumbalis.

This plexus is produced by the union of ramuli from the anterior rami of the five pairs of lumbar nerves. It is deeply seated by the sides of the lumbar vertebræ, being covered by the psoas magnus muscle.

It is connected above, with the dorsal nerves, below, with the sacral plexus, and distributes the following rami.

(A.) *Ramus n. spermaticus externus*—arises from the first lumbar nerve, passes through the substance of the psoas muscle, and in its course receives a branch from the second lumbar nerve, by which it is increased in size, gains the anterior surface of the psoas muscle, and then divides into two ramuli.

(*a.*) *Ramulus n. internus*—takes the course of the spermatic cord, passing with it through the internal abdominal ring, inguinal canal, external ring, and is lost upon the integuments of the scrotum, and the superior and inner part of the thigh.

(*b.*) *Ramulus n. externus*—passes underneath Poupart's ligament with the femoral vessels, and there divides into numerous ramusculi, which soon become sub-cutaneous, and supply the middle part of the thigh, uniting with the anterior crural nerve.

(B.) *Ramus n. cutaneus externus, vel musculo-cutaneus*—arises from the first three pairs of lumbar nerves, which form a kind of plexus, from which three ramuli are sent off.

(*a.*) *Ramulus n. abdominalis*—descends upon the quadratus lumborum, as far as the spine of the ilium, penetrates the transverse muscle, imparting filaments to both, and then divides into two ramusculi.

(α.) *Ramusculus n. externus*—distributes itself to the obliqui and transversalis muscles, and the integuments of the abdomen.

(β.) *Ramusculus n. internus*—descends between the transversus and obliquus internus muscles, runs along the edge of the crural arch as far as the external abdominal ring, where it pierces the tendon of the external abdominal oblique muscle, and is lost on the integuments of the groin and scrotum.

(*b.*) *Ramulus n. descendens*—passes downwards in front of the iliacus internus muscle, pierces the transversalis muscle at the crista of the ilium, and divides into numerous filaments to supply the muscles of the abdomen, and integuments of the pubic region.

(*c.*) *Ramulus n. cutaneus.*—The filaments which form this ramulus, may be traced principally to the third pair of lumbar nerves; it takes its course through the psoas muscle, gains its outer edge, passes over the quadratus and iliacus muscles, under Poupart's ligament, close to the anterior and superior spinous process of the ilium, and having gained the thigh, divides into two ramusculi, which penetrate the crural aponeurosis, and are distributed to the integuments of the posterior and outer part of the thigh, some of its filaments descending as low as the outer side of the knee.

(c.) *Ramus n. cruralis*—arises from that part of the lumbar plexus produced by the first four pairs of lumbar nerves; it passes downwards and outwards, between the psoas and iliacus muscles, and opposite to the fourth lumbar vertebra, it gets to the outer side of the psoas, along which it runs, behind the fascia iliaca under Poupart's ligament, to gain the thigh, where it divides into numerous ramuli, which take a superficial and a deep-seated course.

(*a.*) *Ramuli n. superficiales*—usually about five or six in number, immediately pierce the crural aponeurosis, and divide into many filaments, which distribute themselves to the integuments on the inner and anterior part of the thigh, descending as low as the knee. One ramusculus in particular, is usually found accompanying the saphena major vein in the upper part of the thigh.

(*b.*) *Ramuli n. profundi*—divide themselves into an external and an internal set; they descend outwards, anterior to the iliacus muscle, and behind the sartorius and rectus, separating into numerous filaments that are distributed to the rectus, vastus externus, sartorius, and tensor vaginæ femoris muscles. The internal set are distributed to the vastus internus, pectineus, and triceps adductor femoris muscles. It sends off also—

(*α.*) *Ramusculus n. saphenus*—usually accompanies the femoral artery within the sheath, as far as the tendinous canal of the adductor magnus muscle; this ramusculus then leaves the artery, passes to the popliteal region, and then passing downwards between the sartorius and gracilis, and behind the tendon of the sartorius, about two inches below the head of the tibia, penetrates the aponeurosis, and becoming sub-cutaneous, accompanies the saphena major vein as far as the great toe, distributing cutaneous filaments in its course.

(D.) *Ramus n. obturatorius*—is smaller than the anterior crural, and arises from the second, third, and fourth pairs of lumbar nerves; it passes downwards and inwards, along the inner edge of the psoas muscle, in the direction of the linea ilio pectinea, accompanied by the ramus arteriosus obturatorius, and gains the obturator internus muscle, which fills up the obturator foramen; it sends off a ramusculus which is distributed to that muscle and to the levator ani; it then passes through the foramen, reaches the upper and inner part of the thigh, and behind the adductor femoris muscle divides into an anterior and a posterior ramulus.

(*a.*) *Ramulus n. anterior*—passes forwards between the adductor muscles, which it supplies, as well as the gracilis, and sends off cutaneous filaments that pierce the fascia lata, and unite with filaments of the ramus nervosus cruralis.

(*b.*) *Ramuli n. posteriores*—pass backwards to supply principally the adductor magnus muscle, giving filaments also to the obturator externus, and uniting with the ramus n. sciaticus.

(E.) *Ramus n. sacro lumbalis*—is formed by filaments from the anterior branches of the fourth and fifth pairs of lumbar nerves, which having united with each other, pass downwards into the pelvis, in front of the sacrum, to be connected with the sacral nerves, which unite with it to form the sciatic plexus; previous to which, however, the ramus sacro lumbalis sends off—

(*a.*) *Ramulus n. glutæus superior.*—The filaments of this branch may be traced from the fourth and fifth lumbar pairs, or may be said to arise from the sacro-lumbar plexus; immediately it is formed, it passes out of the ischiatic notch above the pyramidal muscle, and divides into ramusculi which take the course of the ramulus arteriosus glutæus profundus, and supply the glutæus medius and minimus muscles.

Nervi Sacrales,

Consist of six pairs, sometimes however of only five; they arise from the spinal marrow by two sets of filaments, similar to the other spinal nerves, and form the termination of the cauda equina. The ganglia formed by their posterior roots are placed within the sacral canal; the six pair of sacral nerves pass through the anterior sacral foramina, and then divide into posterior and anterior branches.

(27.) *Nervi sacrales primi.*

(A.) *Ramus n. posterior*—is a very small branch, and immediately it has passed through the sacral foramen, it unites with the second pair of sacral nerves, and they together form numerous filaments that supply the sacro-spinalis muscle, and terminates in the glutæus maximus, and integuments of the glutæal region.

(B.) *Ramus n. anterior*—is considerably larger than the preceding, and unites with the sacral ganglia of the sympathetic nerve, and then passing outwards terminates by assisting in forming the sciatic plexus.

(28 to 30.) *Nervi sacrales*—2nd, 3rd, 4th.

(A.) *Rami n. posteriores*—of all these nerves are alike in passing through their corresponding foramina, uniting with each other, and in being distributed to the muscles and integuments of the nates, hip, and margin of the anus; they increase from the first to the fourth, and diminish then to the sixth.

(B.) *Rami n. anteriores*—are alike in being united with the sacral ganglia of the sympathetic nerve, and in entering into the composition of the sciatic plexus; they diminish in volume from above downwards.

(31, 32.) *Nervi sacrales*—5th, 6th.

(A.) *Rami n. posteriores*—are smaller than the posterior branches of the other nerves; they communicate with the fourth pair, and are lost by supplying the parts about the anus.

(B.) *Rami n. anteriores.*—That of the fifth passes through a foramen common to the sacrum and os coccygis; that of the sixth, if it be present, through a notch in the latter bone. They unite with each other, with the fourth, and with the sacral ganglia of the sympathetic, and supply the coccygeus, levator and sphincter ani muscles; and assist in forming the hypogastric plexus.

Plexus Sciaticus,

Is formed by the anterior branches of the fifth lumbar, and of the four upper pairs of sacral nerves, which unite to produce a large nerve, termed the *nervus ischiadicus.* This plexus is situated, deeply seated, in the lateral region of the pelvis, resting upon the pyramidal muscle, and being covered by the iliac vessels, and viscera of the pelvis; it furnishes numerous rami, which may be distinguished by their distribution into an anterior and posterior set; the anterior supplying the viscera within the pelvis, while the posterior set principally pass out of the pelvis.

(A.) *Rami n. hæmorrhoidales*—are small filaments, which take their origin from the anterior part of the plexus, and immediately penetrate the posterior parietes of the rectum, and then divide into ascending and descending ramuli—the former running upwards towards the sigmoid flexion of the colon, the latter to the sphincter and verge of the anus, accompanied by the arterial ramusculi.

(B.) *Rami n. vesicales*—are variable in number, are frequently united to the last-described rami, passing over the sides of the rectum, they gain the posterior part of the bladder to be distributed to its muscles, and mucous membrane; some of these filaments pass to supply the organs of generation.

(C.) *Rami n. vaginales, et uterini*—arise from the sciatic plexus in common with the last described rami, pass around the rectum, then separate from the vesical nerves, and are distributed to the lateral regions of the vagina, and its mucous membrane; the superior filaments are distributed to the uterus.

(D.) *Ramus n. glutæus inferior*—arises from the posterior part of the sciatic plexus, and from the second and third pairs of sacral nerves, passes out of the pelvis through the sciatic notch, below the pyriform muscle, and then divides into three principal ramuli.

(*a.*) *Ramulus n. glutæus medius*—ascends and ramifies upon the superior part of the under surface of the glutæus maximus muscle, taking the course of the ramulus arteriosus glutæus superficialis; some of its ramusculi also descend, penetrate the substance of the muscle, in which they are finally lost.

(*b.*) *Ramulus n. sciaticus, vel pudendalis* — descends downwards and inwards, then turns upwards under the tuberosity of the ischium, when it divides into numerous filaments to supply the inferior part of the glutæus maximus, the integuments upon the inner, and superior part of the thigh, and of the perineum and penis.

(*c.*) *Ramulus n. cruralis*—is the largest of the three, passes in front of the glutæus maximus, then becomes subcutaneous, descends in the back part of the thigh, and expends itself by distributing filaments to the skin which covers the back part of the leg.

(D.) *Ramus n. pudicus internus*—arises from the third and fourth sacral nerves, and from the sacral plexus; it is connected above, with the inferior gluteal nerve, and passes out of the pelvis with it through the ischiatic notch, below the pyriform muscle; it then re-enters the pelvis by the lesser sciatic notch, between the two sacro-sciatic ligaments, accompanying the ramus arteriosus pudicus, and divides into two ramuli.

(*a.*) *Ramulus n. inferior*—takes its course forwards, along the inner side of the tuberosity of the ischium, sending filaments to the levator and sphincter ani muscles, and skin and fat about the anus; it still proceeds forwards and upwards, along the perineum, between the erector penis, and accelerator urinæ muscles, to both of which it sends filaments, and is ultimately lost by supplying the scrotum.

(*b.*) *Ramulus n. superior*—leaves the inferior branch, passing upwards from the ramus of the ischium to that of the pubes, to gain the symphysis, from whence it passes between the pubes and the corresponding crus of the penis, to gain the upper surface of that organ, along which it passes as far as the corona glandis, where it terminates by sending filaments to the skin of the prepuce. In this course it distributes filaments to the obturator muscle, and erector penis, as well as to the skin.

In the female, the inferior ramulus is much larger than in the male; it sends off filaments to the perineum, enters the labium externum, distributes filaments to it, to the constrictor vaginæ, to the erector clitoridis, and is ultimately lost on the mons veneris. The superior ramulus, which is comparatively small, terminates on the clitoris, much in the same manner as the distribution on the penis of the male.

(E.) *Ramus n. ischiadicus*—is the principal branch of the sacral plexus, arising from all the nerves which enter into its formation, namely, the last lumbar, and four superior sacral; it passes out of the pelvis through the sciatic notch, below the pyramidalis, and above the superior geminis muscle; it then descends along the back of the thigh, lying upon the posterior surface of the geminus superior, obturator internus, and quadratus femoris muscles; it is then placed a little to the inner side of the centre of the space between the trochanter major, and tuberosity of the ischium; from this point it descends along the posterior part of the thigh, anterior to the origins of the muscles of the ham-strings, and lying upon the adductor magnus muscle, as far as the popliteal region, where it divides into two principal terminating ramuli. In its course from the pelvis to the ham, it sends off—

(*a.*) *Ramuli n. musculares*—to the obturator internus, gemini, and quadratus muscles.

(*b.*) *Ramulus communicans*—which forms a union with the inferior gluteal ramus.

(*c.*) *Ramuli musculares inferiores*—to supply the biceps, semi-tendinosus, semi-membranosus, and triceps muscles.

(*d.*) *Ramulus n. cutaneus superior*—is usually separated from the ischiadic ramus, near to its exit from the pelvis; it almost immediately divides into two ramusculi, one of which is distributed to the integuments about the tuberosity of the ischium and nates, while the other passes downwards upon the posterior surface of the thigh, distributing filaments to the skin as far as the calf of the leg.

(*e.*) *Ramulus n. peroneus, vel popliteus externus*—takes its course downwards, along the inner edge of the biceps muscle, as far as the head of the fibula; it then passes forwards, through the peroneus longus muscle, winds around the neck of the fibula, and then divides into two terminating ramusculi; previous to which, it sends off—

(*α.*) *Ramusculus n. cutaneus.*—This is sometimes distributed in two or three filaments, which descend along the outer and back part of the leg, between the gastrocnemius externus muscle and the skin, it unites with the cutaneous filaments of the posterior tibial ramusculus, together supplying the skin in their passage downwards, to the malleolus externus, behind which they pass to terminate by dorsal filaments to the fourth and fifth toes, and filaments to the integuments of the outer side of the foot.

(β.) *Ramusculus n. superficialis, vel musculo-cutaneus*—is separated from the ramulus n. peroneus on the neck of the fibula, from which it passes downwards and forwards, between the peroneus longus, and brevis muscles, to both of which, as well as to the extensor longus digitorum, it sends filaments; and about the middle of the leg, it perforates the fascia, becomes sub-cutaneous, passing downwards towards the outer malleolus, a little above which it divides into an internal and external dorsal ramification; the internal is distributed to the integuments on the dorsum of the foot, and on the first and second toes, communicating with the ramusculus n. saphenus, and with the ramusculus n. tibialis anticus; the external supplies the third, and part of the fourth toe, and communicates with the ramusculus n. cutaneus of the peroneal ramulus.

(γ.) *Ramusculus n. profundus, vel tibialis anterior*—passes through the fibres of the extensor digitorum communis, to gain the anterior surface of the interosseous ligament, where it meets with the ramus arteriosus tibialis anticus, in front of which it descends, they being placed first between the tibialis anticus, and extensor longus digitorum, and then between the tibialis anticus and extensor longus pollicis muscles; they then pass behind the ligamentum annulare, to gain the dorsum of the foot, where the nerve divides into an inner and an outer filament. In this course the ramusculus n. profundus supplies the muscles placed between the tibia and fibula, and one filament rises on the fore part of the knee-joint, and accompanies the ramulus a. recurrens.

The inner dorsal filament continues along the inner edge of the extensor brevis digitorum, which it supplies, as well as the inner interossei muscles, and passing along the space between the metatarsal bones of the first two toes, it dips down to reach the sole of the foot, accompanying the ramulus a. communicans, and unites with the inner plantar nervous ramification.

The outer dorsal filament passes to the outer side of the dorsum of the foot, where it is distributed to the outer part of the extensor brevis digitorum communis, and the outer interossei muscles.

(*f.*) *Ramulus n. tibialis posticus, vel popliteus internus* —is the larger division of the sciatic nerve, and descends nearly vertically through the popliteal region, on the outer side of the semi-membranosus muscle, and behind and to the outer side of the popliteal vessels; it then passes behind the knee-joint, between the two heads of the gastrocnemius externus muscle, and then between the gastrocnemius and soleus muscles; when it gains the leg, it is placed immediately behind the tibia, from which situation it receives the name of the tibial nerve. It continues its course downwards, in front of the soleus muscle, and behind the tibialis posticus and flexor longus digitorum, and on the outer side of the ramus a. tibialis posticus. Towards the lower part of the leg, it becomes comparatively superficial, is placed on the inner side of the tendo Achillis dives into the sulcus of the os calcis, between the heel and the inner malleolus, and divides into internal and external plantar ramusculi. In this course, the ramulus tibialis posticus sends off—

(*α.*) *Ramusculus n. cutaneus tibialis, vel saphenus externus.*—This ramusculus is usually given off immediately above the external condyle of the femur; it descends along the posterior part of the leg, accompanying the saphena minor venous ramulus, and just as it gains the outer side of the tendo Achillis, it becomes united with the cutaneous ramusculus of the ramulus n. peroneus—the two forming a considerable ramusculus; after this union, ramifications are distributed beneath the tendo Achillis, supplying its membranous sheath, and the adjacent parts; the ramusculus then passes behind the external malleolus, takes its course along the superior and external part of the foot, as far as the metatarsal bone of the little toe, where it divides into numerous filaments to supply the muscles and integument of the dorsum of the foot, and terminates by distributing digital filaments to the two outer toes.

In the popliteal region, the ramulus tibialis posticus sends off muscular filaments to the gastrocnemii, soleus, popliteus, plantaris, and tibialis posticus muscles, as well as to the knee-joint; two or three filaments pass through the interosseous ligament, to supply the muscles on its fore part; and just above the malleolus internus, and before its ultimate division, it gives off cutaneous filaments to supply the skin about the inner side of the ankle.

(β.) *Ramusculus n. plantaris internus*—is given off behind the malleolus internus, and posterior to the ramus a. tibialis posticus, which vessel does not divide into its plantar ramuli so soon as the nerve. The ramusculus n. passes forwards along the inner side of the tarsus, above the abductor pollicis muscle, and by the side of the tendon of the flexor longus pollicis, as far as the base of the metatarsal bone of the great toe, where it separates into four digital filaments.

In this course, it sends off filaments to the neighbouring muscles. Its *first digital filament*, takes a course along the tibial side of the great toe; the *second filament*, sub-divides in the space between the metatarsal bone of the great toe and the toe next to it, and supplies the fibula side of the great toe, and the tibial side of the toe next to it; the *third filament*, enters between the second and third metatarsal bones, supplies the lumbricalis muscle, sub-divides into two, which pass to the second and third toes; the *fourth filament*, is in a like manner situated between the third and fourth metatarsal bones, furnishes filaments to the corresponding lumbricalis muscle, and sub-dividing supplies the outer side of the third, and the inner side of the fourth toe.

(γ.) *Ramusculus n. plantaris externus*—is the smaller division of the posterior tibial ramulus; it takes its course forwards and outwards, above the flexor brevis digitorum muscle, to the posterior extremity of the metatarsal bone of the fifth toe, where it divides into a superficial and a deep-seated filament. The superficial filament, divides into digital filaments to supply the outer side of the fourth, and both sides of the little toe, as well as the corresponding lumbricales muscles. The deep-seated filament, passes obliquely inwards, between the interossei and adductor muscle of the great toe, and is lost by supplying the deep muscles of the plantar region.

LECTURE XXXV.

DESCRIPTIVE ANATOMY OF THE SYMPATHETIC NERVE.

This nerve is termed the sympathetic, from its forming such frequent and general communication with all the other nerves of the organismus. It differs from the cerebral and spinal nerves, from its apparent origin from ganglia, which are considered by some physiologists as so many centres of nervous influence, or little brains; and which are placed within the cavities of the trunk, and not found any where in the extremities, or exterior of the body.

The ganglia are reddish grey bodies, destitute of any envelope, of different forms, and having nervous cords, which proceed from their circumference either to be connected with other ganglia, or nerves, or to be lost in some particular organ. The cords which leave these ganglia, pass to some other, and are either to be considered as the trunk of the sympathetic nerve, or perhaps as mere cords of communication between the ganglia themselves: in the first case, it premises the nervous cord as the most important part of the sympathetic nervous system, and the ganglia as merely accessory to the function; while in the second case, the ganglia seem to be the important organs, and the cords as mere media of communication: but which ever view we may take of the comparative importance of these parts, it is the best and easiest mode to gain a just knowledge of the system, to describe the ganglia as they are placed in the head, neck, chest, and abdomen; and to describe their cords of junction, as mere nervous communications.

Ganglia Capitis.

The first ganglion which is usually described, is the ophthalmic or lenticular ganglion, situated within the orbit; but Ribes, a German anatomist, has described some filaments of the sympathetic nerve continuing in the course of the internal carotid artery, as high as its division into its anterior cerebral branches; and that there the filament on one side unites with that of the opposite, and just over the communicating branch of the two anterior cerebral arterial ramuli, form a little ganglion, which has been named the ganglion of Ribes.

(1.) *Ganglion lenticulare, vel ophthalmicum*—is placed on the outer side of the optic nerve, close to its entrance into the orbit; it is small, somewhat oblong, presenting a convex external surface, opposed to the abductor oculi muscle, and a concave internal surface, connected with the optic nerve; it is surrounded by a considerable quantity of semi-fluid fat: the posterior edge of this ganglion, either receives, or sends off two filaments, one of which passes to unite with the nasal ramulus of the first division of the fifth pair, and the other from its posterior and inferior edge to be connected with the outer ramulus of the third pair of nerves.

The anterior edge of the ganglion supplies two sets of rami, one placed above the other, which are destined to supply the interior of the eye—these are called ciliary nerves; they are very delicate, and of a reddish color.

(A.) *Rami ciliares s. superiores*—composed of five or six filaments, proceed from the upper edge of the ganglion, above the optic nerve, accompanied by filaments from the nasal ramulus of the first division of the fifth, to the ball of the eye.

(B.) *Rami ciliares s. inferiores*—composed of from eight to ten filaments, are placed below and to the outer side of the optic nerve, but frequently unite with each other so as to surround it; arriving at the posterior part of the globe of the eye, all the ciliary filaments traverse the sclerotic coat, pass forwards between it and the choroid, running parallel with each other, frequently communicating, and reach the ciliary circle or ligament, where each filament divides into two, which are lost, partly in the substance of the ligament, and partly in the iris.

This ciliary circle or ligament, has been considered by some anatomists, as a true ganglion of the sympathetic nerve.

(2.) The *spheno-palatine, or ganglion of Meckel*—is placed within the spheno-maxillary fossa, below the second division of the fifth pair of nerves; it is small, irregular in its form, having a convexity on its outer surface, and being flattened internally towards the lateral nasal, or spheno-palatine foramen. From this ganglion, rami are sent off superiorly, inferiorly, internally, and posteriorly.

(A.) *Rami s. superiores*—from the upper part, two or three rami pass upwards to be connected with the second division of the fifth pair of nerves.

The filaments given off *inferiorly*, are all distributed to the palate, and are termed the palatine filaments; they are three in number. The first is termed—

(*a.*) *Ramulus s. palatinus magnus.*—It enters the posterior palatine canal, first giving off a small nasal filament, which passes into the nose, and is distributed in the space between the two turbinated bones. The great palatine nerve, continues its course along the palato-maxillary foramen, sending filaments into the nasal fossæ, and is lost by supplying the palate, and gums of the upper jaw.

(*b.*) *Ramuli s. palatini medii*—descends along the posterior part of the palato-maxillary foramen, and comes out of the canal through a foramen which opens in the fossa between the two pterygoid plates, and then divides to be distributed to the soft palate.

(*c.*) *Ramuli s. palatini parvi*—is still posterior to the last, and like it, is distributed to the soft palate, the uvula, and the tonsil.

(B.) *Rami s. interni*—are three or four in number, and are destined to supply the pharynx, and the nose. They are termed the spheno-palatine, or lateral nasal nerves, and pass through the spheno-palatine foramen to gain the nasal fossa, which they enter close to the posterior extremity of the superior turbinated bone, and here spread out upon the pituitary membrane of the superior and middle meatus of the nose, sending also filaments backwards, to supply the pharynx and palate.

There is one filament in particular, termed the—

(*a.*) *Ramulus s. naso-palatinus*—which takes its course from the superior part of the septum of the nose, descending obliquely forwards behind the pituitary membrane, to the opening of the anterior palatine canal of its own side, which it enters, and passing downwards towards the mouth, reaches the foramen incisivum, produced by the union of the canal from each nostril; and here the naso-palatine ramulus of the one side unites with that of the other, and produces a little enlargement, which has been termed by Cloquet, the *spheno-palatine ganglion.* This ganglion receives a filament from the great palatine ramulus.

(c.) *Ramulus s. posterior, vel vidianus, vel pterygoideus*—directs itself horizontally backwards, through the pterygoid foramen or canal, emerging from which, it divides into two ramuli, first sending off within the pterygoid foramen filaments to the septum of the nasal fossæ, and to the pharynx.

(*a.*) *Ramulus s. inferior, vel carotideus*—passes immediately in the carotid canal, applying itself upon the coats of the carotid artery, and uniting with the filament which is connected with the sixth pair of nerves; it descends to be connected with the superior cervical ganglion of the sympathetic; forming, therefore, a medium of communication between the spheno-palatine, the cavernous, and the superior cervical ganglia.

(*b.*) *Ramulus s. superior, vel innominatus*—passes upwards, penetrates the fibro-cartilaginous substance, which closes the foramen lacerum basis cranii anterius, and enters the skull close to the anterior surface of the petrous portion of the temporal bone, where it enters a groove, which conducts it to a foramen termed the foramen innominatum, and which leads to the canal of Fallopius; here it becomes applied to the trunk of the portio dura, with which it passes to a point, at the posterior and inner wall of the cavity of the tympanum, immediately underneath the base of the pyramid, where a foramen is placed, through which it passes; it then traverses the tympanum from behind forwards, first under the incus, then between its long crus and the upper part of the handle of the malleus, with which it is in contact; it then descends forwards, and passes out of the glenoid fissure, continuing its course downwards and inwards to be connected with the ramusculus lingualis of the third division of the fifth pair, and terminating by forming a kind of ganglion around the submaxillary gland, which has been termed the *submaxillary ganglion.* This filament, therefore, forms a communication between the spheno-palatine, and submaxillary ganglia, and is termed the *chorda tympani.* In its course, it sends off a filament while within the cavity of the tympanum, which passes to the promontory and unites with a filament from the internal carotid filament.

Besides the ganglia we have described, there is generally another, situated within the skull, within the cavernous sinus, termed the *cavernous ganglion;* it is very small, of a reddish grey color, placed to the outer side of the internal carotid artery, and sends filaments to be connected with the sixth, the first division of the fifth, the third pair of nerves, and the lenticular ganglion; and also inferior filaments, which are connected with the superior cervical, and Meckel's ganglion.

Ganglia Cervicales.

The ganglia which are found upon the neck, are three in number, and are named according to their relative position, with respect to each other.

The *ganglion cervicale superius*—is of an oval form, of a reddish color, and is placed upon the rectus capitis anticus major, behind the carotid artery, and jugular vein; reaching from the transverse process of the first to that of the third, and sometimes the fourth cervical vertebra, or even lower. Its form and size, are variable; it gives off rami, in the following directions, upwards, downwards, outwards, inwards, and forwards.

(A.) *Rami s. superiores.*—These are two in number, they ascend to enter the carotid canal, and upon the surface of the internal carotid artery, form divisions, so frequently anastomosing with each other, as to produce a distinct plexus; from this plexus a ramulus is connected with the ramulus inferior of the ramus s. vidianus; two or three other ramuli enter the cavernous sinus, and become connected with the sixth pair of nerves, and with the cavernous ganglion, as well as with the first division of the fifth. There are other small ramuli, which pass to the pituitary shaft; also some delicate ramuli pass into the cavity af the tympanum from the carotid canal, where on the promontory they unite with the superior ramulus of the vidian ramus, and with a filament of the glosso-pharyngeal nerve, which latter gains the tympanum through a foramen close to the stylo-mastoid foramen, which opens into that cavity.

According to Ribes, a filament is described as taking the course of the central arterial ramulus of the retina; which he considers as forming a communication between it and the superior cervical ganglion.

(B.) *Ramus s. inferior*—descends from the inferior extremity of the superior, to the middle cervical ganglion, which is situated opposite to the fifth or sixth cervical vertebra, where it terminates; the size of this ramus is variable; its consistence resembles more that of the cerebral, than of the sympathetic nerves; it descends vertically in front of the rectus capitis anticus major, and the longus colli muscles; behind the carotid artery, jugular vein, and pneumo-gastric nerve, exterior to their sheath. In this tract, it receives some filaments from the third and fourth pairs of cervical nerves; it also unites with the external laryngeal ramulus of the par vagum, and sends off two or three delicate filaments, which pass into the chest, and assist in forming the cardiac plexus.

(c.) *Rami s. externi*—are numerous; above, they unite by several filaments, with an arch formed around the transverse process of the atlas, by the union of the anterior branches of the sub-occipital, and first pair of cervical nerves; another filament subdivides, and communicates with the anterior branches of the second and third pairs of cervical nerves; while the inferior of these external rami, unite with the anterior branches of the fourth pair of cervical nerves, and with the cervical plexus.

(d.) *Rami s. interni*—are soft and delicate nerves; they distribute filaments to the rectus capitis anticus major, and longus colli muscles; and terminate in the larynx and pharynx—assisting the glosso-pharyngeal, and par vagum nerves in forming the pharyngeal plexus.

(e.) *Rami s. anteriores*—are numerous and large, and have been sometimes called the nervi molles; the upper are the shortest, and ascend to unite with the portio dura, pneumo-gastric, and lingual nerves, soon after they pass out of the skull. The inferior pass downwards, are two or three in number, directing themselves from behind, forwards, to the point of division of the common carotid artery, where they form a plexus, from which numerous ramuli are distributed, with the branches of the common carotid artery, and the carotid plexus; uniting also with filaments from the par vagum, and portio dura. The inferior one or two of these anterior rami unite to form the ramulus cardiacus superficialis, vel superior; of which we shall speak more particularly hereafter.

Ganglion Cervicale Medius.

This ganglion does not always exist; under which circumstance, the inferior ramus of the superior cervical ganglion descends to the neck of the first rib, to terminate in the inferior cervical ganglion; but when present, it is situated close to the ramulus a. thyroidalis inferior, opposite to the sixth cervical vertebra. Its form is somewhat rounded; it is bounded behind, by the longus colli muscle, on which it rests; before, by the carotid artery, jugular vein, and pneumo-gastric nerve. It sends off inferior, external, internal, and anterior rami.

(A.) *Rami s. inferiores*—small, usually from five to six in number, descend—some posterior, and some anterior to the subclavian artery, to terminate in the inferior cervical ganglion.

(B.) *Rami s. externi*—sometimes emanate in a single branch, pass outwards usually through the scalenus anticus muscle, and unite with the three inferior cervical nerves.

(C.) *Rami s. interni*—accompany the inferior thyroideal arterial ramulus, around which they form a plexus. Some pass to the thyroideal gland, œsophagus, and trachea, uniting with the recurrent laryngeal ramus n. of the par vagum; and one filament unites with the phrenic nerve.

(D.) *Rami s. anteriores*—are two or three in number, which unite in forming the ramulus s. cardiacus medius, which will be hereafter described.

Ganglion Cervicale Inferius.

Is very irregular in its form, frequently appearing to consist of several small ganglia, connected by a reddish intermediate tissue; it is situated behind the vertebral artery, between the transverse process of the seventh cervical vertebra, and the neck of the first rib, as well as between the scalenus anticus, and the longus colli muscles; it furnishes superior, inferior, external, internal, and anterior rami.

(A.) *Rami s. superiores.*—Some of these communicate with the middle cervical ganglion, others pass upwards upon the vertebral artery, forming a plexus upon it, and are described as passing upwards as high as the second cervical vertebra, where they unite with the sub-occipital nerve. Small filaments from this *vertebral plexus*, unite with each of the cervical nerves, as they emanate from the intervertebral foramina.

(B.) *Ramus s. inferior*—communicates with the first thoracic ganglion.

(C.) *Rami s. externi*—are very numerous, surround the subclavian artery, around which they form a plexus, and subdivide to accompany the branches of that artery. Some of these rami also unite with the anterior branches of the last four pairs of cervical, and with the first dorsal nerve.

(D.) *Rami s. interni*—are few in number, and take their course partly to the longus colli muscle, and in part assist in forming the pulmonary plexus, and unite with the recurrent laryngeal ramulus of the par vagum, and with the phrenic nerves.

(E.) *Rami s. anteriores*—form the inferior cardiac nerve.

The cardiac nerves should now be described. These are three in number on each side; and as they arise from the superior, middle, and inferior sympathetic ganglia, they are accordingly named the superior, middle, and inferior cardiac rami.

(A.) *Ramus cardiacus superior, vel superficialis*—arises by four or five lower anterior filaments of the superior cervical ganglion; these having united, form a small cord, which descends along the neck, by the side of the trachea and thyroid gland, behind the carotid artery, to the chest. In this course, it sends filaments to assist in forming the pharyngeal plexus; it also sends some to the thyroid gland, and others to be connected with the pneumo-gastric nerve. As it arrives in its descent opposite to the middle cervical ganglion, it sends off a filament, which becomes connected with the inferior thyroideal plexus of that ganglion, and unites with the descending cervical ramus of the hypoglossal nerve. The superior cardiac ramus then enters the chest, behind the subclavian vein, and there becomes intimately connected with the recurrent laryngeal ramus of the par vagum, and with the inferior cervical ganglion. The superficial cardiac nerve of the left side, descends into the chest, between the common carotid, and the subclavian arteries, where it divides into numerous filaments; some of which pass over the aorta, to unite with the inferior cardiac ramus, and cardiac filaments of the pneumo-gastric nerve; while others pass behind the aorta, and assist in forming the posterior cardiac plexus.

(B.) *Ramus s. cardiacus medius, vel magnus*—is upon the right side larger than the other cardiac nerves; it arises by four or five of the anterior filaments from the middle cervical ganglion, and descends along the inner side of the common carotid artery, passes in front of the subclavian artery to gain the chest; here uniting in its course with the recurrent laryngeal ramus, and pneumo-gastric nerve. It then descends obliquely inwards, passing along the outer side of the arteria innominata, to reach the space between the arch of the aorta and the trachea, where it terminates in the cardiac plexus. On the left side, the middle cervical cardiac ramus s. is not unfrequently wanting, and generally receives its principal branch from the inferior cervical ganglion.

(C.) *Ramus s. cardiacus inferior.*—The filaments which form this ramus on the right side, spring from the inferior cervical ganglion, and immediately form a plexus, which descends vertically behind the subclavian artery, uniting with filaments from the recurrent ramus; they then pass along the left side of the arteria innominata, upon the anterior surface of the arch of the aorta, and between it and the pulmonary artery, assisting in forming the anterior cardiac plexus. Most frequently, on the left side, the middle, and inferior cardiac rami unite to form a single trunk; under which circumstance, the cardiacus superior, and the cardiacus profundus pass separately to the heart; and on the right side, the cardiacus superior and inferior unite, leaving the cardiacus medius to pass separately.

Plexus Cardiacus.

This plexus is placed behind the ascending aorta, near its origin from the left ventricle, and in front of the right pulmonary artery; it is of an irregular form, and is made up of filaments proceeding from the cardiac rami of the opposite sides, as well as of filaments from the pneumo-gastric nerves, and their recurrent rami.

In this plexus several small ganglia are enclosed, and to the whole of them the term of cardiac ganglion is sometimes applied. This plexus receives at its upper part, the right and left middle cardiac rami; on the left side, principally filaments from the cardiacus superficialis; and on the right side, from the ramus cardiacus inferior: while there emanate from this ganglion, anterior, inferior, and posterior rami.

(A.) *Rami s. anteriores*—are small and few in number, and are distributed to the anterior parietes of the aorta.

(B.) *Rami s. posteriores*—terminate in the pulmonary plexus.

(C.) *Rami s. inferiores*—are very numerous, and are distributed especially to the heart; some of them pass backwards, encircling the posterior coronary artery, and forming a complete plexus around its branches, pass into the substance of the heart, where they terminate; others pass forwards, surrounding the aorta, and produce the anterior cardiac plexus, between the aorta, pulmonary artery, and vena cava. From the cardiac ganglion, numerous filaments take the course of the pulmonary vessels, unite with filaments of the pneumo-gastric nerve, and assist in forming the pulmonary plexus, which upon the left side surrounds the ductus arteriosus.

Ganglia Thoracica.

There are twelve ganglia on each side of the thorax, placed behind the pleura, one anterior to the head of each rib: sometimes there are but eleven, the last cervical, and the first dorsal being united. Each of these ganglia is small, and triangular in figure, the first being the largest; they communicate with one another, and send off external, and internal rami.

(A.) *Rami s. communicantes.*—These are single branches of considerable size, and extend from the inferior edge of the ganglion above, to the superior edge of the ganglion below.

(B.) *Rami s. externi*—from two to four in number from each ganglion, take their course upwards and outwards, and almost immediately unite with a small branch from the anterior ramus of each dorsal nerve, as it emanates from the intervertebral foramen.

(c.) *Rami s. interni*—are very numerous, and variable in their distribution. Those from the upper ganglia, are the shortest, and terminate in the interior of the chest, communicating frequently with each other in front of the vertebral column, and uniting with the pulmonary plexus. While those from the inferior ganglia are longer, and generally from the sixth to the twelfth, unite to form the two splanchnic rami.

(d.) *Ramus s. splanchnicus major*—arises from the inner edges of the thoracic ganglia, from the sixth to the ninth or tenth, by four or five filaments, which take their course downwards along the sides of the vertebral column, and opposite to the tenth dorsal vertebra unite to form a single branch, which passes through the lesser muscle of the diaphragm into the abdomen; and immediately above the capsula renalis, it divides into numerous filaments to unite with the ramus splanchnicus major of the opposite side, through the medium of the great semilunar ganglion, at the root of the cœliac axis.

(e.) *Ramus s. splanchnicus minor*—is formed by the junction of rami arising from the two or three inferior thoracic ganglia; it passes into the abdomen by perforating the diaphragm behind the great splanchnic branch; and terminates partly by uniting with the greater splanchnic, and in part by forming the renal plexus.

Ganglia Abdominales.

Ganglion Semilunare.

One on each side placed on the pillars of the diaphragm, partly upon the aorta, at the root of the cœliac artery, above and a little behind the capsula renalis; above, the semilunar ganglia receive the greater splanchnic rami; and below, as they converge towards each other, they sometimes unite directly, so as to form but one ganglion; more frequently, however, this union is only by small filaments. That of the right side, is the larger of the two; it is placed between the right pillar of the diaphragm and the vena cava: that of the left side, is placed upon the left pillar of the diaphragm, and generally lies upon the right diaphragmatic artery, being covered by the tail of the pancreas. It is also between the splenic vein, which is above it, and the left renal artery, which is below it.

Both the semilunar ganglia are surrounded by several other ganglia, termed the cœliac, which are connected with each other by numerous short filaments, the whole producing the solar plexus; from which, sets of filaments again are sent off, forming plexuses, taking the course of the arteries from the aorta, and are named accordingly.

(A.) *Plexus s. diaphragmaticus*—arises from the superior part of the solar plexus; there are but few filaments which enter into its composition, and they terminate by taking the course of the diaphragmatic arteries, and by uniting with the phrenic nerve.

(B.) *Plexus s. cœliacus.*—The filaments forming this plexus, are sent off from the inferior part of the solar plexus, assisted by filaments of the pneumo-gastric, and phrenic nerves; when thus produced, it subdivides into three other plexuses.

(*a.*) *Plexus s. coronarius*—takes its course with the ramus arteriosus coronarius of the cœliac artery, which it embraces near its origin; following the course of the lesser curvature of the stomach, it is distributed to its coats, and communicates with the pneumo-gastric nerve.

(*b.*) *Plexus s. hepaticus*—much larger than the former, surrounds the hepatic artery, and vena portæ, passing with them through Glisson's capsule to the substance of the liver, to which it is distributed, accompanying the ramifications of the hepatic vessels. It also sends filaments to the ductus communis cholidochus, duodenum, greater curvature of the stomach, and gall bladder; and receives filaments from the right pneumo-gastric nerve.

(*c.*) *Plexus s. splenicus*—accompanies in a similar manner the ramifications of the splenic artery into the spleen, and like the ramifications of that artery, supplies the pancreas, the left extremity of the stomach, and the omentum.

(C.) *Plexus s. mesentericus superior.*—The solar plexus continues along the fore-part of the aorta, from the cœliac, as low as the superior mesenteric artery, where filaments accompany that vessel, and form the superior mesenteric plexus. This plexus then descends with the superior mesenteric artery, between the pancreas and duodenum, then between the two layers of the mesentery, where it forms a net-work surrounding the mesenteric glands, and which sends off filaments, that follow the course of the arterial rami to the pancreas, duodenum, colon, and cæcum.

(D.) *Plexus s. mesentericus inferior*—is composed of filaments, which proceed along the front of the aorta, down as low as the inferior mesenteric artery, where they take the course of that vessel, and form the inferior mesenteric plexus, being distributed with the arterial branches. Just as it is passing into the pelvis, this plexus divides into two portions—the inner of which takes the course of the common iliac artery, and its distributions; the outer portion passes with the hæmorrhoidal branch of the superior mesenteric artery to the meso-rectum.

(E.) *Plexus s. renalis*—one on each side is made up of filaments from the solar, and cœliac plexus, and from the lesser splanchnic nerve. It is furnished with small ganglia, situated behind the emulgent artery and vein, the ramifications of which they accompany into the substance of the kidney.

(F.) *Plexus s. spermaticus*—formed principally from the renal plexus, and partly also from the superior mesenteric; its filaments take the course of the spermatic artery, in the male, to the testicle, and in the female, to the ovaria and Fallopian tubes.

Ganglia Lumbales—

Are usually five on either side, placed on the lumbar vertebræ, behind the vena cava on the right, and the aorta on the left side. They send off communicating external, and internal rami.

(A.) *Rami s. communicantes*—are filaments which unite the five ganglia with each other; these filaments are sometimes united in one cord, at others separated into three or four. The first connects the last thoracic ganglion with the first lumbar, and the lower one, the last lumbar with the first sacral.

(B.) *Rami s. externi*—are usually two or three from each ganglion; they cross in front of the lumbar arteries, the upper filaments being directed obliquely upwards, the middle ones transversely, and the lower ones downwards. They pass between the origins of the psoas muscle, and opposite to the intervertebral foramina unite with the anterior rami of the lumbar nerves.

(C.) *Rami s. interni*—are numerous, but extremely delicate, frequently uniting with each other in front of the aorta; they form the *aortic plexus;* from which filaments are distributed to be united with the several plexuses we have described, and the inferior filaments unite with the hypogastric plexus.

Ganglia Sacrales.

Are three or four on either side, placed upon the anterior surface of the sacrum, behind the peritoneum; like the lumbar, they send off communicating, external, and internal rami—the two latter, concurring in forming the hypogastric plexus.

(A.) *Rami s. communicantes*—form a junction between each of the sacral, and between the last lumbar and first sacral ganglia.

(B.) *Rami s. externi*—are of considerable size, and unite with the anterior branches of the sacral nerves, partly to be distributed to the levator ani muscle.

(C.) *Rami s. interni*—are small, and unite within the middle of the sacrum from the opposite side; from which union filaments are sent off, that assist in forming the hypogastric plexus.

Plexus Hypogastricus.

This plexus is formed by filaments derived from the sciatic, inferior mesenteric, and aortic plexuses, as well as by filaments from the sacral ganglia.

The hypogastric plexus distributes ramifications to the rectum, bladder, vesiculæ seminales, in the male; uterus, and vagina, in the female; accompanying the arterial branches which are distributed to those parts.

The last pair of sacral ganglia sends off filaments, which pass downwards and inwards on the anterior surface of the os coccygis, on which they unite, producing a little ganglion, which has been termed the *ganglion impar;* from the under surface of which, delicate filaments are distributed, which lose themselves on the extremity of the os coccygis.

TABLE OF THE NERVES.

CEREBRAL NERVES.

1. First pair, or olfactory.
2. Second pair, or optic.
3. Third pair, or motores oculorum.
    - A. *Ramus nervosus superior.*
        - *a.* Ramulus n. musculi recti superioris.
        - *b.* Ramulus n. m. levatoris palpebræ superioris.
    - B. *Ramus n. inferior.*
        - *a.* Ramulus n. m. adductoris oculi.
        - *b.* Ramulus n. m. recti inferioris.
        - *c.* Ramulus n. m. obliqui inferioris.
4. Fourth pair, or pathetici.
5. Fifth pair, or trigeminus.
    - A. *Ramus n. ophthalmicus.*
        - *a.* Ramulus n. lachrymalis.
            - α. Ramusculus n. spheno-maxillaris, vel communicans.
            - β. Ramusculus n. malaris.
        - *b.* Ramulus n. frontalis.
            - α. Ramusculus n. super-trochlearis.
            - β. Ramusculus n. supra-orbitalis.
        - *c.* Ramulus n. nasalis.
            - α. Ramusculus n. ganglionicus.
            - β. Ramusculus n. nasalis internus.
            - γ. Ramusculus infra-trochlearis.
    - B. *Ramus n. maxillaris superior.*
        - *a.* Ramulus n. orbitalis.
            - α. Ramusculus n. malaris.
            - β. Ramusculus n. temporalis.
        - *b.* Ramuli n. dentales posteriores.

- *c.* Ramulus n. infra-orbitalis.
    - α. Ramusculi n. externi et interni.
    - β. Ramusculus n. dentalis anterior.
- C. *Ramus n. maxillaris inferior.*
  - *a.* Ramulus n. superior.
    - α. Ramusculi n. temporales profundi
    - β. Ramusculi n. masseteres.
    - γ. Ramusculus n. buccales.
    - δ. Ramusculi n. pterygoidei.
  - *b.* Ramulus n. inferior.
    - α. Ramusculus n. lingualis, vel gustatorius.
    - β. Ramusculus n. dentalis inferior.
    - γ. Ramusculus n. auricularis, vel temporalis superficialis.

6. SIXTH PAIR, OR ABDUCENTES.
7. SEVENTH PAIR—PORTIO DURA, OR FACIAL NERVE.
   - A. *Rami n. musculares.*
   - B. *Ramus n. auricularis posterior.*
     - *a.* Ramulus n. anterior.
     - *b.* Ramulus n. posterior.
   - C. *Ramus n. stylo-hyoideus.*
   - D. *Ramus n. digastricus.*
     - *a.* Ramulus n. superior.
     - *b.* Ramulus n. inferior.
   - E. *Ramus n. temporo-facialis.*
     - *a.* Ramuli temporales.
     - *b.* Ramuli malares.
     - *c.* Ramuli buccales.
   - F. *Ramus n. cervico-facialis.*
     - *a.* Ramuli n. supra-maxillares.
     - *b.* Ramuli n. infra-maxillares.
8. EIGHTH PAIR—PORTIO MOLLIS, OR AUDITORY NERVE.
   - A. *Ramus n. cochlearis.*
   - B. *Ramus n. vestibuli.*
     - *a.* Ramulus magnus.
     - *b.* Ramulus medius.
     - *c.* Ramulus minimus.

9. NINTH PAIR, OR GLOSSO-PHARYNGEAL NERVES.
    - A. *Ramus n. anastomoticus.*
    - B. *Rami n. communicantes.*
    - C. *Rami n. pharyngei.*
    - D. *Ramus n. lingualis superior.*
        - *a.* Ramulus n. tonsillaris.
    - E. *Ramus n. lingualis inferior.*
    - F. *Ramus n. lingualis medius.*
10. TENTH PAIR—PAR VAGUM, OR PNEUMO-GASTRIC NERVES.
    - A. *Rami. n. communicantes.*
    - B. *Ramus n. pharyngeus.*
    - C. *Ramus n. laryngeus superior.*
        - *a.* Ramulus n. laryngeus externus.
        - *b.* Ramulus n. laryngeus internus.
            - *α.* Ramusculi n. superiores.
            - *β.* Ramusculi n. inferiores.
    - D. *Rami n. cardiaci.*
    - E. *Ramus n. laryngeus inferior, vel recurrens.*
        - *a.* Ramuli n. cardiaci.
        - *b.* Ramuli n. pulmonares.
    - F. *Rami n. pulmonares.*
    - G. *Rami n. œsophagei.*
    - H. *Rami n. ventriculares.*
11. ELEVENTH PAIR—HYPO-GLOSSUS, OR LINGUAL NERVE.
    - A. *Ramus n. cervicalis descendens.*
        - *a.* Ramuli n. musculares.
        - *b.* Ramulus n. lingualis.
            - *α.* Ramusculi n. musculares.

SPINAL NERVES.

1. NERVUS ACCESSORIUS WILLISII.
    - A. *Ramus n. communicans.*
    - B. *Ramus n. pharyngeus accessorius.*
2. NERVI SUB-OCCIPITALES.
    - A. *Ramus n. anterior.*
        - *a.* Ramuli n. musculares.

- B. *Ramus n. posterior.*
    - *a.* Ramulus n. occipitalis superior et internus.
    - *b.* Ramulus n. occipitalis superior et externus.
    - *c.* Ramulus n. occipitalis inferior, vel cervicalis.

NERVI CERVICALES.

3. NERVI CERVICALES PRIMI.
    - A. *Ramus n. anterior.*
        - *a.* Ramulus n. ascendens.
            - *α.* Ramusculi n. communicantes.
        - *b.* Ramulus n. descendens.
    - B. *Ramus n. posterior, vel occipitalis magnus.*
        - *a.* Ramuli n. musculares.
4. NERVI CERVICALES SECUNDI.
    - A. *Ramus nervosus anterior.*
        - *a.* Ramulus n. ascendens.
        - *b.* Ramulus n. descendens.
    - B. *Ramus posterior.*
5. NERVI CERVICALES TERTII.
    - A. *Ramus n. anterior.*
    - B. *Ramus n. posterior.*

PLEXUS CERVICALIS.

- A. *Ramus n. descendens internus.*
- B. *Ramus n. diaphragmaticus, vel phrenicus.*
- C. *Rami n. descendentes externi.*
    - *a.* Ramuli n. supra-claviculares.
    - *b.* Ramuli n. supra-acromiales.
    - *c.* Ramuli n. sub-claviculares.
    - *d.* Ramuli n. cervicales profundi.
- D. *Rami n. ascendentes.*
    - *a.* Ramulus n. superficialis colli.
    - *b.* Ramulus n. auricularis.
    - *c.* Ramulus n. occipitalis minor.

6. NERVI CERVICALES QUARTI.

7, 8, 9. NERVI CERVICALES—5th, 6th, 7th.

Plexus Axillaris.

- A. *Rami n. thoracici.*
  - *a.* Ramulus n. anterior.
  - *b.* Ramulus n. posterior.
- B. *Ramus n. suprascapularis.*
- C. *Rami n. infra subscapulares.*
- D. *Ramus n. articularis, vel circumflexus.*
- E. *Ramus n. cutaneus internus.*
  - *a.* Ramulus n. externus.
  - *b.* Ramulus n. internus.
- F. *Ramus n. cutaneus internus minor.*
- G. *Ramus n. cutaneus externus, vel musculo-cutaneus.*
  - *a.* Ramulus n. posterior.
  - *b.* Ramulus n. anterior.
- H. *Ramus n. medianus.*
  - *a.* Ramuli n. musculares.
  - *b.* Ramulus n. interosseous.
  - *c.* Ramulus n. palmaris cutaneus.
  - *d.* Ramulus n. digitalis primus.
  - *e.* Ramulus n. digitalis secundus.
  - *f.* Ramulus n. digitalis tertius.
  - *g.* Ramulus n. digitalis quartus.
  - *h.* Ramulus n. digitalis quintus.
- I. *Ramus n. ulnaris, vel cubitalis.*
  - *a.* Ramulus n. palmaris.
    - *α.* Ramusculus n. profundus.
    - *β.* Ramusculus n. superficialis.
  - *b.* Ramulus n. dorsalis.
    - *α.* Ramusculus n. internus.
    - *β.* Ramusculus n. externus.
- K. *Ramus n. radialis, vel spiralis.*
  - *a.* Ramuli n. musculares.
  - *b.* Ramulus n. cutaneus posterior.
  - *c.* Ramulus n. anterior, vel superficialis.
    - *α.* Ramusculus n. externus.
    - *β.* Ramusculus n. internus.

- *d.* Ramulus n. posterior.
  - α. Ramusculi n. posteriores.
  - β. Ramusculi n. anteriores.

NERVI DORSALES.

- A. *Rami n. posteriores.*
  - *a.* Ramuli n. interni.
  - *b.* Ramuli n. externi.
- B. *Rami n. anteriores.*

10. NERVI DORSALES PRIMI.
  - B. *Ramus n. anterior.*
    - *b.* Ramulus n. descendens.

11. NERVI DORSALES SECUNDI.
  - B. *Ramus n. anterior.*
    - *a.* Ramulus n. intercostalis.
    - *b.* Ramulus n. brachialis.

12. NERVI DORSALES TERTII.
  - B. *Ramus n. anterior.*
    - *a.* Ramulus n. intercostalis.
    - *b.* Ramulus n. brachialis.

13 to 16. NERVI DORSALES—4th, 5th, 6th, 7th.
  - B. *Rami n. anteriores.*
    - *a.* Ramuli n. interni.
    - *b.* Ramuli n. externi.

17 to 20. NERVI DORSALES—8th, 9th, 10th, 11th.
  - B. *Rami n. anteriores.*
    - *a.* Ramuli n. interni.
      - α. Ramusculi n. profundi.
      - β. Ramusculi n. superficiales.
    - *b.* Ramuli n. externi.

21. NERVI DORSALES—12th.
  - B. *Rami n. anteriores.*
    - *a.* Ramulus n. communicans.

NERVI LUMBALES.

22. NERVI LUMBALES PRIMI.
  - A. *Ramus n. posterior.*

- B. *Ramus n. anterior.*

23 to 26. NERVI LUMBALES—2nd, 3rd, 4th, 5th.

PLEXUS LUMBALIS.

- A. *Ramus n. spermaticus externus.*
  - *a.* Ramulus n. internus.
  - *b.* Ramulus n. externus.
- B. *Ramus n. cutaneus externus, vel musculo-cutaneus.*
  - *a.* Ramulus n. abdominalis.
    - *α.* Ramusculus n. externus.
    - *β.* Ramusculus n. internus.
  - *b.* Ramulus n. descendens.
  - *c.* Ramulus n. cutaneus.
- C. *Ramus n. cruralis.*
  - *a.* Ramuli n. superficiales.
  - *b.* Ramuli n. profundi.
    - *α.* Ramusculus n. saphænus.
- D. *Ramus n. obturatorius.*
  - *a.* Ramulus n. anterior.
  - *b.* Ramuli n. posteriores.
- E. *Ramus n. sacro-lumbalis.*
  - *a.* Ramulus n. glutæus superior.

NERVI SACRALES.

27. NERVI SACRALES PRIMI.

- A. *Ramus n. posterior.*
- B. *Ramus n. anterior.*

28 to 30. NERVI SACRALES—2nd, 3rd, 4th.

- A. *Rami n. posteriores.*
- B. *Rami. n. anteriores.*

31, 32. NERVI SACRALES—5th, 6th.

- A. *Rami n. posteriores.*
- B. *Rami n. anteriores.*

PLEXUS SCIATICUS.

- A. *Rami n. hæmorrhoidales.*
- B. *Rami n. vesicales.*

C. *Rami n. vaginales, et uterini.*
D. *Ramus n. glutæus inferior.*
  a. Ramulus n. glutæus medius.
  b. Ramulus n. sciaticus, vel pudendalis.
  c. Ramulus n. cruralis.
D. *Ramus n. pudicus internus.*
  a. Ramulus n. inferior.
  b. Ramulus n. superior.
E. *Ramus n. ischiadicus.*
  a. Ramuli n. musculares.
  b. Ramulus n. communicans.
  c. Ramuli n. musculares inferiores.
  d. Ramulus n. cutaneus superior.
  e. Ramulus n. peroneus, vel popliteus externus.
    α. Ramusculus n. cutaneus.
    β. Ramusculus n. superficialis, vel musculo cutaneus.
    γ. Ramusculus n. profundus, vel tibialis anterior.
  f. Ramulus n. tibialis posticus, vel popliteus internus.
    α. Ramusculus n. cutaneus tibialis, vel saphenus externus.
    β. Ramusculus n. plantaris internus.
    γ. Ramusculus n. plantaris externus.

NERVUS SYMPATHETICUS.

GANGLIA CAPITIS.

1. GANGLION LENTICULARE, VEL OPHTHALMICUM.
   - A. *Rami sympathetici superiores, et inferiores, vel ciliares.*
2. GANGLION SPHENO-PALATINE, OR GANGLION OF MECKEL.
   - A. *Rami s. superiores.*
   - B. *Rami s. inferiores, vel palatini.*
     - *a.* Ramulus s. palatinus magnus.
     - *b.* Ramuli s. palatini medii.
     - *c.* Ramuli s. palatini parvi.
   - C. *Rami s. interni, vel spheno-palatini, or lateral nasal.*
     - *a.* Ramulus s. naso-palatinus.
   - D. *Ramus s. posterior vidianus, vel pterygoideus.*
     - *a.* Ramulus s. inferior, vel carotideus.
     - *b.* Ramulus s. superior, vel innominatus.

GANGLIA CERVICALIA.

Ganglion cervicale superius.

- A. *Rami s. superiores.*
- B. *Ramus s. inferior.*
- C. *Rami s. externi.*
- D. *Rami s. interni.*
- E. *Rami s. anteriores.*

GANGLION CERVICALE MEDIUM.

- A. *Rami s. inferiores.*
- B. *Rami s. externi.*
- C. *Rami s. interni.*
- D. *Rami s. anteriores.*

GANGLION CERVICALE INFERIUS.

- A. *Rami s. superiores.*
- B. *Ramus s. inferior.*
- C. *Rami s. externi.*
- D. *Rami s. interni.*
- E. *Rami s. anteriores.*

RAMI S. CARDIACI.

A. *Ramus s. cardiacus superior, vel superficialis.*
B. *Ramus s. cardiacus medius, vel magnus.*
C. *Ramus s. cardiacus inferior, vel parvus.*

PLEXUS CARDIACUS, OR CARDIAC GANGLION.

A. *Rami s. anteriores.*
B. *Rami s. posteriores.*
C. *Rami s. inferiores.*

GANGLIA THORACICA.

A. *Rami s. communicantes.*
B. *Rami s. externi.*
C. *Rami s. interni.*
D. *Ramus s. splanchnicus major.*
E. *Ramus s. splanchnicus minor.*

GANGLIA ABDOMINALIA.

GANGLION SEMILUNARE.

A. *Plexus s. diaphragmaticus.*
B. *Plexus s. cœliacus.*
    a. Plexus coronarius.
    b. Plexus hepaticus.
    c. Plexus splenicus.
C. *Plexus s. mesentericus superior.*
D. *Plexus s. mesentericus inferior.*
E. *Plexus s. renalis.*
F. *Plexus s. spermaticus.*

GANGLIA LUMBALIA.

A. *Rami s. communicantes.*
B. *Rami s. externi.*
C. *Rami s. interni.*

GANGLIA SACRALIA.

A. *Rami s. communicantes.*
B. *Rami s. externi.*
C. *Rami s. interni.*

PLEXUS HYPOGASTRICUS.

LECTURES ON ANATOMY.

PART IX.

THE ORGANS OF THE SENSES.

LECTURE XXXVI.

THE ORGANS OF THE SENSES.

Descriptive Anatomy of the Organs of Vision.

These organs are placed within those cavities formed by the junction of the bones of the face, which are termed the orbits. They have already been described with the bones of the head. *(Vide* Vol. I. p. 70.*)*

The student, after referring to the osteological description of these cavities, should next examine them in reference to the eyes, and observe how well they are adapted, not only for the purposes of protection, but also to afford a varied range of motion for the purposes of vision. In aid of this object, we find the situation of the orbits contributes much to the perfection of this function; thus the superior and fore part of the head is admirably chosen for many important purposes in the animal economy, as their vicinity to the immediate seat of the intellect, and nervous communication with the brain, render them capable of being adapted, by their exalted position and extensive motion, for the perception of surrounding objects.

It may also be observed, that the orbits are much larger than the globes of the eyes; this is not only for the purposes of enclosing, at the same time, the numerous muscles, nerves and blood-vessels, which contribute to the function of vision; but also to admit a motion of the eyes, independent of all the other parts of the body. Besides this protection from the bony orbits, the external delicacy of the eye requires an apparatus for the purpose of defending it from the effects of the air, and other external objects, as well as to moderate and modify the degree of light passing to the organ.

Thus we have surrounding the orbits, the eyebrows, eyelids, eyelashes, meibomian glands, and lachrymal apparatus; all performing their separate functions, in aid of the perfection of vision.

These parts have been termed by Haller, the *tutamina oculi.*

Of the eyebrows, or supercilia.—These are two eminences, resting upon the superciliary ridges of the frontal bone, covered by short hairs, which are directed from within outwards. They are larger internally, which extremity is called their head, they are arched in their centre, and their thinner and outer extremity is sometimes called their tail. The color of these hairs is usually that of the hair of the head. A considerable quantity of fat is placed between the skin of the eyebrows, and the superciliary ridges of the frontal bone, admitting of a motion produced by the orbiculares palpebrarum, corrugatores superciliorum, and the occipito frontalis muscles.

The eyebrows are supplied with nerves from the first division of the fifth pair, and from the facial; they derive their blood from the temporal, and palpebral ramusculi of the internal carotid arterial ramus.

Use.—To protect the eyes from perpendicular rays of light, to prevent the perspiration of the forehead from lodging on the eyelids; and also they may be considered as organs of mental expression, indicating thought, surprise, and anger.

The *eyelids, or palpebræ*—are two moveable curtains, placed in front of the eye, and are distinguished into an upper and a lower. The upper is bounded above by the eyebrow, and the lower one below by the cheek.

When the eyelids are closed, so that their free extremities are in contact with each other, the upper, it may be observed, from its larger size, descends so as to form the greater portion of the covering to the eye; and the motion of the lower eyelid, is comparatively limited. Both lids are convex externally, and concave internally, in a degree corresponding to the convexity of the anterior part of the lobe of the eye. They unite at their transverse extremities, forming two angles, the inner is the greater; which disposition depends upon the arrangement of the fibres of the orbicularis palpebrarum, having a tendon between them internally and not externally. The skin of both eyelids is thrown into numerous folds, by the action of the orbicular muscles; they are more numerous upon the upper, which are concave downwards, while those of the lower have their concavities directed upwards.

The free extremities of each eyelid, present numerous small orifices; towards the internal angle, one may be observed on each lid, which is termed the *punctum lachrymale.* Besides these, there are little orifices that point out the termination of the ducts of the meibomian glands, along the whole length of the lids; these open inwards, towards the eyes; and in front of them are placed the eyelashes, which are short stiff hairs—those on the upper lid being directed upwards, and those on the lower, downwards.

The following tissues, enter into the composition of the eyelids.

The *skin*—which differs only from the cutaneous covering of the other parts of the body, in being extremely delicate, in not being connected to the sub-cutaneous tissues by adipose membrane, and in being semi-transparent. Underneath the skin is situated the orbicularis palpebræ muscle; towards the outer circumference of this muscle, the fibres are separated widely from each other, so as to afford an indistinct appearance of musclar fibre; but towards the free edges of the lids, the fibres are closer, larger, and straighter, forming what has been considered by some anatomists as a distinct muscle, which they have named the *m. tarsalis.*

A fibrous tissue—is situated under this muscular layer of each eyelid, which is stronger on the outer side, and is placed on the upper lid, between the orbicularis and the tendon of the levator palpebræ superioris, and in the lower lid, between the orbicularis and the tunica conjunctiva. It is inserted into the tarsal cartilages, and is connected with the circumference of the orbits; it is particularly obvious on the outer side, but becomes so attenuated on the inner, as to be lost in cellular membrane. The tendinous expansion of the levator palpebræ superioris, crosses this fibrous layer, as it passes to be inserted into the tarsal fibro-cartilage, and serves to strengthen the fibrous tissue of the upper eyelid.

Fibro-tarsal cartilages — are one to the upper, and another to the lower lid of each eye. They have their elastic laminæ, placed in the free edges of the lids, at the termination of the fibrous tissues just described. At the inner canthus, the cartilages of the two lids are connected with the tendon of the orbicularis muscle; and at the outer, they terminate by uniting, through the medium of the fibrous tissue, with each other. The fibro-cartilage of the upper lid is larger than that of the lower, and of a different form, so as to enable the one to be distinguished from the other; it is broad in its centre, and contracted at its extremities; the broadest part of the upper measuring usually about six lines, while in the lower it is not more than two; but it presents nearly the same measurement in its whole length. They are convex upon their anterior, and concave upon their posterior surfaces; the latter presenting many vertical grooves, which lodge the meibomian glands. The adherent edges of these cartilages, are attached to the fibrous layers of the eyelids; their free edges are thick, and somewhat bevelled, so that when the eyelids are brought in contact, a little groove is formed by their approximation, which is supposed to be for the purpose of conveying the tears from the outer, to the inner canthus of the eye.

The *meibomian glands*—are small rounded follicles, of a yellow color, which are placed between the tarsal cartilages, and the tunica conjunctiva, arranged in parallel vertical lines. These are described by Soemmerring as being about forty in the upper, and not more than twenty on the lower lid. These follicles communicate with each other, and open at the free extremities of the eyelids, upon the fore part of the eye, through very minute apertures, which are placed behind the ciliæ in two transverse rows. The substance which is secreted by these glands, is of a sebaceous quality, and sufficiently firm to be squeezed out in a cylindrical form.

The *ciliæ, or eyelashes*—are strong hairs, placed in rows upon the anterior free extremity of each eyelid, but are more numerous and stronger upon the upper, than on the lower. They are so disposed, that those on the upper are directed upwards, with a slight curve, and those on the lower lid, with a curve downwards; so that the convexities formed by these curves, are opposed to each other when the eyelids are closed; but the free extremities of the hairs of each eyelash are so separated, as to prevent their entanglement.

Tunica conjunctiva, or membrana adnata.—This membrane belongs to the mucous system, and not only covers the posterior surface of the eyelids, but also the anterior surface of the globe of the eye. It is still a matter of dispute, whether or not this membrane is continued over the transparent cornea; the distinct fibrous or laminated structure of the cornea, and the complete absence of such an appearance in the conjunctiva, would lead one to doubt this being the case: while, again, the continuity of pustular disease over this portion of the globe of the eye from the eyelids, seems to argue for the continuation of this membrane over the whole of the fore part of the organ. At the free edges of the eyelids, the tunica conjunctiva is continuous with the cutis, and is pierced by the ducts of the meibomian glands; or more properly, should be considered as passing into their apertures to form the follicular apparatus, as it passes through the puncta lachrymalia, to form the lachrymal duct and ductus ad nasum. At the inner canthus of the eye this tunic forms a fold, presenting a small projection of a pale red color, which is termed the *caruncula lachrymalis;* in which may be observed small follicles, and very minute hairs; and immediately to the outer side of the caruncula, another indistinct fold may be observed, which from its situation, and resemblance to a similar structure, but much more developed in certain animals, has been termed the membrana nictatans.

Practical Remarks.

The use of the eyelids is to protect the eye from light bodies, which are constantly floating in the atmosphere, as well as, by their frequent involuntary closing, to offer a relief to the retinæ by an alternate exclusion and admission of light. They also, by the same motion, convey the tears from the upper and outer part of the orbit to the puncta lachrymalia, which are situated at the inner canthus; this object is not merely to lubricate the surface of the eye, or to wash off light bodies which are brought in contact with it; but to spread over its anterior surface a thin layer of tear, which produces a refractive medium between that of the atmosphere and of the transparent cornea:—a theory, which is proved by the power of vision becoming imperfect when the tear is wiped off the globe of the eye. The eyelids are liable to numerous diseases, from the derangement of the several structures entering into their formation; namely, those of the skin, cellular membrane, muscle, fibrous membrane, fibro-cartilage, meibomian glands, and hairs; each of which are liable to peculiar diseases.

Of the Parts contained within the Orbit.

It has already been said, that the globe of the eye only in part fills up the orbits; the remaining space being occupied by a considerable quantity of fat, by the muscles, arteries, veins, nerves, and absorbents of the organs.

The adeps contained within the orbit, so surrounds the globe of the eye, as completely to imbed, and form a soft cushion for it, protecting the globe from friction on the bone; and perhaps at the same time, may be useful in moderating the action of the muscles, and preventing too great an alteration in the refractive power of its transparent parts. For these purposes, the adeps within the orbit is found enveloped in large cells, and of a very soft consistence.

The *muscles* of the eye, are six in number—four of which, from their direction, are named the straight, and two the oblique. The levatores palpebrarum superiorum, have already been mentioned (*Vide* Vol. II. p. 71,) as moderators to the orbiculares palpebrarum.

The *recti* muscles—are named according to their use, as levator, depressor, abductor, and adductor muscles.

Musculus levator oculi—arises from the upper surface of the foramen opticum, immediately beneath the levator palpebræ superioris, and is somewhat connected with the neurilema of the optic nerve; it then passes forwards on the upper surface of the ball of the eye, where it becomes aponeurotic, and is inserted into the sclerotic coat, anterior to the transverse axis of the globe; its upper surface is covered by the levator palpebræ superioris, from which, anteriorly, it is separated by the tunica conjunctiva. Its inferior surface rests upon the optic nerve, the ramulus a. ophthalmicus, and the nasal n. ramulus of the first division of the fifth pair.

Use.—To raise the eye.

M. depressor oculi—arises from the under surface of the optic foramen, by a tendon common to it, the adductor and abductor oculi muscles; it passes forwards, along the under surface of the globe of the eye, anterior to the great diameter of which it is inserted, similar to the last-described muscle. Its inferior surface is in contact with a quantity of adeps, and its tendinous insertion is covered by the tunica conjunctiva; its upper surface is in connection with the optic nerve, and the inferior ramus of the third pair.

Use.—To antagonize the levator oculi, and consequently to direct the pupil downwards.

M. abductor oculi—is placed on the outer side of the orbit; it has a double origin, partly from the optic foramen, and partly from a tendon which is attached to the edge of the foramen lacerum orbitale superius; between which two origins, the third pair of nerves, the sixth, and the ramulus nasalis of the first division of the fifth, enter the orbit. The muscle passes horizontally outwards and forwards, beyond the transverse axis of the globe, to be inserted by an aponeurosis into the sclerotic coat. Its external surface is in contact with the orbitar process of the sphenoid bone, and more anteriorly with the lachrymal gland; its internal surface, with the optic nerve, the lenticular ganglion, and sixth pair of nerves, which ramify on it.

Use.—To direct the pupil outwards. The peculiarity to be observed with respect to these muscles, is, that they receive a distinct pair of nerves, namely, the abducentes, which receive a filament from the sympathetic. No clear physiological theory has been formed upon this anatomical fact.

M. adductor oculi—arises from the inner side of the optic foramen, from which it passes forwards, anterior to the diameter of the globe, where it becomes aponeurotic, and is inserted into the sclerotic coat. Its internal surface corresponds to the orbitar process of the œthmoid bone, its external to the optic nerve.

Use.—To direct the pupil inwards. In taking a view of the direction given by each of these muscles to the globe of the eye, first, by their separate, and secondly, by their collective action, it will be obvious, that the field of motion is as extensive and varied, as the sphere of vision can require; and yet a mystery hangs over the action of two other muscles, which are connected with this organ.

M. obliquus superior oculi—arises by a short aponeurosis from the upper and inner part of the optic foramen, where it is somewhat connected with the origin of the levator palpebræ superioris. It proceeds forwards along the orbitar process of the œthmoid bone, towards the internal angular process of the frontal bone, where a cartilaginous pully is fixed, through which the tendon of this muscle passes, and is then reflected, passing from above downwards, backwards, and outwards, to be inserted by aponeurosis midway between the vertical diameter of the globe, and the entrance of the optic nerve.

Use.—To draw the point of insertion of the muscle forwards, inwards, and upwards, making the globe of the eye perform a rotatory motion, which directs the pupil downwards, and outwards. These muscles receive the fourth pair of nerves, which are wholly distributed to them.

M. obliquus inferior oculi—is situated at the under and fore part of the orbit, arising from the orbitar process of the superior maxillary bone, above the infra-orbitar foramen, and just to the outer side of the lachrymal groove; from this origin it passes obliquely outwards, backwards, and upwards, to be inserted by a tendinous expansion into the sclerotic coat, behind the transverse axis of the eye, close to the entrance of the optic nerve; its inferior surface lies upon the orbitar process of the superior maxillary bone, the upper is connected with the ball of the eye, and the depressor oculi muscle.

Use.—To draw the point of insertion of this muscle forwards, inwards, and downwards, and consequently to direct the pupil backwards, outwards, and upwards. Such would be its separate action; but when in combination with the preceding muscle, they draw the eye forwards, and counteract the combined power of the four straight muscles.

The *lachrymal apparatus*—consists of the lachrymal gland, and lachrymal passages, which are placed within the orbits.

The *lachrymal gland*—is a conglomerate gland, placed in a depression in the upper and outer part of the orbit, on the inner side of the external angular process of the os frontis, above the abductor oculi, and covered by the tunica conjunctiva. It is about the size of a small almond, of a pale red color, of an oval figure; it may be separated in two or three lobes, which are further separable into small granules, connected by cellular tissue. Each of these granules receives a small ramification from the ramulus a lachrymalis, and from which a small ramification of a vein commences, as well as a distinct excretory duct, which unites with others, so that the whole gland does not produce more than seven or eight ducts, opening upon the inner side of the upper eyelid, arranged in a curved row—the convexity of which is directed upwards. The whole gland is surrounded by a distinct capsule.

The *puncta lachrymalia*—are two small orifices to each eye, one on either eyelid; they occupy the centre of a little tubercle, more or less obvious in different individuals, situated about a line and a half from the inner canthus. That of the upper eyelid is directed downwards, outwards, and backwards; and that of the lower, upwards, backwards, and outwards; both are therefore curved in such a manner that their convexities are directed towards each other. These puncta are the orifices of the—

Lachrymal ducts—which extend from the puncta to the lachrymal sac; the upper is rather longer than the lower, and more curved; both of them open into the sac, rather above the centre of its outer side, and immediately behind the tendon of the orbicularis muscle. They usually open separately into the sac; but sometimes they unite before they reach it.

Lachrymal sac—is a small membranous pouch, composed of mucous membrane, placed at the inner canthus of each eye, and lodged in a bony groove formed by the os unguis and superior maxillary bone. This sac is closed above, and rises superior to the tendon of the orbicularis muscle, which covers its anterior surface, as well as some of the fibres of the orbicular muscle, and the integuments; its inferior extremity is continuous with the nasal ducts.

The interior of the lachrymal sac is lined by a continuation of the tunica conjunctiva, which afterwards lines the nasal duct and nose itself; its color is red, and it is always moistened by mucus. Its outer surface is covered by some muscular fibres, besides those of the orbicularis palpebræ, which have been spoken of by anatomists as a distinct muscle; but they appear to me to be part of the obliquus inferior, which may contribute in some measure to press its fluid contents towards the nose. It receives its blood from the ramusculi a. palpebrales of the ophthalmic ramulus, and its nervous filaments from the ramulus n. nasalis.

Nasal duct.—The bony canal which has already been described in Vol. I. p. 72. It is lined by a continuation of the mucous membrane of the sac, which adheres very firmly to the periosteum, and opens in the inferior meatus of the nose, under the inferior turbinated bone, by a small orifice, which is surrounded by a circular projection of pituitary membrane;

the direction of the duct, from its commencement at the sac to its termination in the nose, is obliquely backwards, and a little outwards.

The *tears*—which are secreted by the lachrymal glands, and directed downwards and inwards by the action of the orbiculares palpebrarum muscles to the puncta, to be ultimately conveyed to the nose; are a muco-serous fluid, the specific gravity of which is somewhat greater than water; and according to Fourcroy, contains water, mucus, muriate of soda, soda, phosphate of lime, and phosphate of soda.

The saline parts amount only to about 0· 01 of the whole. Under common circumstances, the tears are principally, at any rate, in a great measure removed by evaporation; as may be proved by the liability of the tears to flow over upon the cheek, when the atmosphere is loaded with moisture; but when from mental emotion, or any other cause, the lachrymal gland is excited to inordinate secretion, then the tears fall upon the cheek, producing what is termed weeping. The secretions from the Meibomian glands prevent the tears, in a great measure, from passing over the lids; as do also the ciliæ, excepting between the puncta lachrymalia and the inner angle of the eye, where there are no hairs placed, and where the tears therefore most readily accumulate and pour over. Towards this part of the eye, the tears are conveyed by the closing of the lids; and here the puncta absorb them, probably by capillary attraction, and they flow into the lachrymal sac, from which they are propelled by the action of the orbicular, and perhaps inferior oblique muscles, into the nasal duct, and from thence into the nose. Any interruption of the flow of the tears through the lachrymal passages, produces a consequent weeping; it may depend upon disease of the puncta, lachrymal sac, or duct. If the symptoms depend upon disease of the puncta, or sac, they may usually be removed by injecting warm water through the lower punctum; but when they are produced by obstruction in the nasal duct, the sac should be laid open, and a style passed through the duct into the nose, and allowed to remain there until the passage is re-established —or a probe may be passed up the nasal duct from the nose.

Of the Globe of the Eye.

The parts which compose the globe of the eye, are the membranes or tunics, the humours, and also substances of a peculiar nature, as the crystalline lens, and the ciliary bodies; beside numerous vessels and nerves. The ball of the eye is spherical, its greater diameter is from before to behind, in which direction it is usually about eleven lines in length; while its other diameters are only ten lines. The globe of the eye is not completely circular, the transparent cornea being a portion of a smaller sphere, projecting on its anterior part. This projection forms about a fifth of the ball of the eye.

The eye is bounded anteriorly, by the tunica conjunctiva; posteriorly, by the straight and oblique muscles, vessels, and nerves, and a considerable quantity of fat; above and to the outer side, by the lachrymal gland; below and to the inner side, by the lachrymal passages.

Tunica sclerotica—extends from the entrance of the optic nerve, to the circumference of the transparent cornea, forming about four-fifths of the circular investment of the eye; it is a dense, fibrous substance, of a pearly whiteness, and is thicker posteriorly than anteriorly; its external surface is convex, and is covered by the muscles of the eye, and their tendinous insertions, and by the tunica conjunctiva; its inner surface is covered by the choroid coat, with which it is connected by blood-vessels, and nerves, and a delicate cellular membrane. A little to the nasal side, on the posterior surface of the sclerotic coat, is found a perforation for the entrance of the optic nerve; this is sometimes a single foramen, at others a cribriform plate. There are also numerous small foramina, for the passage of the ciliary vessels and nerves. Anteriorly, the sclerotic coat terminates by a circular opening, the edge of which is bifid, to receive the transparent cornea, in a similar manner to that in which the rim of a watch receives the glass; of these bifid edges, the exterior is the largest.

At the point where the muscles of the eye become tendinous, the sclerotic coat acquires the metallic lustre of tendon; while posterior to this point, it presents an opaque whiteness, in which situation it is stronger, and more distinctly fibrous.

At the point where the optic nerve leaves the skull, the dura mater forms a distinct envelope to it, accompanying it as far as the entrance into the sclerotic coat, where it leaves the nerve, and connects itself with that tunic.

Cornea pellucida—forms the anterior fifth of the ball of the eye; it is not perfectly circular, its vertical being less than its transverse axis, which is seven lines in length. Its anterior surface is convex, more or less prominent in different individuals, and is supposed by some anatomists to be covered by the tunica conjunctiva, and by others, by a mucous layer of a nature peculiar to itself; its posterior surface is concave, and covered by the serous membrane of the aqueous humor: its circumference is received within the sclerotic coat, in a manner which has already been described, its edge corresponding to the bifid groove which receives it.

The cornea is thicker than the sclerotic, being one third of a line, but is not like it fibrous; being composed of five or six concentric lamellæ, united by a very delicate cellular membrane, containing an aqueous fluid.

Tunica choroides—is placed between the sclerotic coat and the retina, and extends from the entrance of the optic nerve to the ciliary ligament; it is of a dark brown color, being composed of a congeries of minute blood-vessels, united by a thin cellular tissue; posteriorly, it presents a narrow opening for the optic nerve; while anteriorly, it unites itself intimately to the ciliary ligament; its outer surface is covered with a brownish pigment, formed of small globules, which after death tinge the inner surface of the sclerotic coat. The inner surface is covered much more abundantly by the pigmentum nigrum, which does not stain the retina, being separated from it by a reflected serous membrane, first discovered by Mr. Jacobs, of Dublin, and now termed the membrana Jacobi.

The choroid coat consists of two layers, which are separable posteriorly, but inseparable when connected with the ciliary ligament; here it becomes puckered, forming a number of delicate folds, which surround the crystalline lens and anterior surface of the vitreous humor. This coat appears to be composed entirely of blood-vessels; the arteries are divided into two sets, the long, and the short; the former are two in number, pass forwards by the sides of the choroid coat, and reaching the ciliary ligament are directed inwards, to be distributed to the iris: the vessel on the outer side, is a little above that which runs on the inner side of the eye. The short ciliary arteries are much more numerous than the former, pierce the sclerotic coat sooner, and then immediately divide into numerous ramifications, which anastomose upon the choroid coat. The veins of the choroid coat are larger than the arteries, and pass from before backwards, describing arches, and converging towards the posterior part of the eye, where they form three or four distinct venous trunks, which pierce the sclerotic coat, and terminate in the ophthalmic vein, which empties itself into the cavernous sinus. Ruysch separated these vascular distributions from each other, dividing them into two layers, the inner of which has gained the name of the membrana Ruyschiana, and secretes the pigmentum nigrum.

Ligamentum ciliare—is a grey ring, of considerable firmness, forming a boundary to the anterior extremity of the choroid coat, and a bond of union between the sclerotic and choroid coats, and the iris. Its broadest part is not more than two lines in breadth, it is of a pulpy consistence, and from receiving the distribution of the ciliary nerves, and sending off other nerves to the iris, it has been considered by some anatomists as a ganglion, although its structure is unknown.

Of the iris.—This is a delicate circular membrane, suspended vertically from the ciliary ligament, and behind the transparent cornea, so as to separate the space between the crystalline lens and the cornea into chambers, the anterior of which is much the larger of the two. They communicate with each other freely through the central aperture of the iris, which is called the pupil. The pupil is not placed in the centre of the iris, but rather nearer to its nasal than its temporal side. The iris has the power, during life, of contracting and expanding, so as to vary the dimension of the pupil.

The circumference of the iris corresponds to the ciliary ligament; the opening in its centre forms the limits of the pupil; its anterior surface, forming the posterior boundary of the anterior chamber of the eye, is covered by the membrane of the aqueous humor, and presents different colors in different individuals, but which in some measure correspond with the color of the hair. On this surface may be observed striæ, passing from the outer circumference towards the pupil, where they meet other striæ, appearing like a fasciculus of circular fibres surrounding the pupil. These fibres have been supposed by some anatomists to be muscular; and Dr. Maunroir, of Geneva, considered the radiating fibres were for the purpose of dilating, while the circular fibres were for the purpose of contracting the pupil, and forming a sphincter muscle.

There is every reason to believe that the pupil is under the influence of a sphincter muscle, which, like the other sphincters in the body, has a tendency to remain permanently closed—and to be opened only by the action of its moderators. This is evinced by the circumstance which occurs upon the exhibition of a powerful narcotic, which, overcoming the action of voluntary muscles, leaves the pupil permanently contracted. This occurred but a short time since at Guy's Hospital, in a woman who made an attempt to destroy herself, by taking a large quantity of laudanum.

The posterior surface of the iris is covered by pigmentum nigrum, which, in the intervals of the ciliary processes, is continuous with the inner surface of the choroid coat; and when the posterior surface of the iris is washed, a number of converging striæ may be observed, passing from the circumference of the pupil, where they become blended, so as to form a membranous zone.

The iris is abundantly supplied with nerves and arteries, in a manner which has already been described. In the fœtus, the pupil, up to the seventh month of utero-gestation, is closed by a delicate vascular membrane, termed the membrana pupillaris; which is supposed to be formed of a division of the aqueous membrane into two distinct bags, uniting at the pupil, and which afterwards becomes ruptured.

On the choroid coat, ciliary ligament, and iris being dissected off, the retina is exposed—which should next be considered.

The *retina*—as usually described, is placed between the choroid coat, and the vitreous humour; but there is, in fact, placed between them Jacob's membrane, which will be afterwards noticed. The retina extends from the optic nerve, with which it is continuous, nearly as far forwards as the corpus ciliare, within about two lines of which it terminates by a distinct edge. Its structure is soft, and pulpy; and from the manner in which it commences from the optic nerve, it does not seem to be the expansion of that nerve, but rather, as considered by M. Ribes, as a membrane to receive the distribution of its medullary structure. After death, the retina is semi-transparent, and of a pale white color; it appears to be formed of two layers, which are separable, and more readily so when the central artery has been injected. Upon the inner layer, the distribution of this vessel may be traced, rendered quite vascular, while the outer layer is medullary. This division may also be demonstrated by macerating the eye for some days, when the medullary substance may be washed off, and the vascular coat left entire. Anterior to the apparent termination of the retina, just posterior to the corpus ciliare, there is a structure proceeding forwards to the crystalline lens, of which various opinions have been formed. Many anatomists consider it as a continuation of the retina, which they describe therefore, as terminating at the circumference of the lens. The late Sir William Adams considered it as a distinct structure, and from its tenacity and firmness named it the ligament of the retina. At any rate, it is demonstrable that there is a substance resting on the hyaloid membrane, and placed between the defined line, forming the apparent termination of the retina, and the crystalline lens; which to me appears to be a continuation of the tunica vasculosa retinæ—the medullary layer terminating at the point described, two lines posterior to the corpus ciliare; anterior to which its prolongation could afford no service to vision, as the rays refracted by the lens could not impinge it. The inner layer is termed the *tunica vasculosa retinæ.*

On the inner surface of the retina, about two lines to the outer or temporal side of the entrance of the optic nerve, a yellow spot (termed by Soemmerring the "*limbus luteus,*") may be seen, in the centre of which is situated the "*foramen centrale.*" These appearances being placed immediately in the axis of vision, have led to much physiological speculation with respect to their use, although little or nothing seems to be known about them.

Besides the two layers of the retina, which have been described, it receives a distinct external covering from Jacob's membrane, which, according to some dissections made by my friend Mr. John Dalrymple, seems to be a distinct serous membrane, covering both the external surface of the retina, and the internal surface of the choroid coat. That a membrane did exist between the retina and choroid coat, was first demonstrated by Mr. Jacob, of Dublin, whose name has been given to it; but he did not describe it as a closed serous bag. This membrane may be shewn, by carefully tearing the choroid through, and everting it, when small portions of Jacob's membrane may be detached from the retina, and by inflation, rendered distinct from the medullary layer.

The *corpus ciliare*—is a dark ring, constituted by the union of all the ciliary processes, posteriorly; it is bounded behind, by the retina; before, by the ciliary processes; on its outer circumference, by the choroid coat; and on its inner, by the hyaloid membrane.

From its anterior edge from sixty to eighty small vasculo-membranous bodies project, placed beside each other, which are the—

Ciliary processes.—They pass forwards, surround the circumference of the crystalline lens, projecting into the posterior chamber, and are placed behind the iris and the ciliary ligament. These processes are alternately, long and short;

and as there is a space between each two of them, the hyaloid membrane and circumference of the crystalline lens become stained in these spaces by the pigmentum nigrum, in consequence of the choroid and hyaloid membranes coming in contact.

The form of each ciliary process is triangular; the base is attached to the ciliary body, the apex is free in the posterior chamber of the eye; the superior surface is directed forwards to the iris, and the inferior backwards to the lens.

The Humours of the Eye.

The *aqueous humour*—enclosed within its proper membrane, is placed immediately behind the transparent cornea, and occupies the anterior and posterior chambers of the eye, so as to be opposed both to the anterior and posterior surface of the iris, and the anterior surface of the crystalline lens. Its quantity is about six grains; it is secreted by its membrane, which is capable of reproducing it in a very short space of time, if it be evacuated either by accident, or during any operation.

The aqueous humour is slightly viscid; it does not coagulate, either by acids or alcohol; nor if submitted to heat, does it deposit any residuum. Its s. g. is 1·0003; it contains, according to Brande, a minute quantity of albumen; and according to Chenevix, gelatin, albumen, and some small quantity of salines.

In the fœtus, the aqueous humour has a reddish tint.

The *crystalline lens*—is placed between the aqueous and the vitreous humours; and with respect to its situation in the eye, is at about the junction of the two posterior thirds with the anterior third of the organ. It is not exactly placed in the centre of the antero-posterior axis of the globe, but rather to its nasal side—its axis corresponding to that of the pupil; it presents two convex surfaces, the posterior of which is more prominent than the anterior. It is surrounded by a fine capsule proper to it, which is described as being denser, and more elastic anteriorly, than posteriorly; its specific gravity is 1·0790. As to its chemical composition, it differs from the aqueous humour in containing a greater quantity of gelatin, and albumen, and in the absence of saline substances; upon the application of heat, it becomes perfectly opaque. Within its capsule, a small quantity of fluid is contained between it and the lens, which is termed the *liquor Morgagni*—the lens itself being composed of a concentric laminated structure, soft and semi-fluid at its outer surface, and harder as it approaches the centre, where it has a nucleus, nearly of a solid consistence.

The crystalline lens is held in its situation by the splitting of the hyaloid membrane, one layer of which passes anterior, and the other posterior to it. Where the two layers of the hyaloid membrane reach the circumference of the crystalline lens, a triangular space is left, which runs around the lens, and is termed the *canal of Petit.* This canal is intersected by small septa, which give to it a vesicular appearance when inflated.

Such is the description of the canal of Petit, given by most anatomists; but there are others, who believe that the hyaloid membrane does not pass in front of the lens, but that it is situated wholly behind it; and that the membrane of the aqueous humor covers the lens in front, and uniting at its circumference with the hyaloid membrane, assists in forming the canal of Petit. If the lens be boiled, or exposed to maceration, it will separate into a number of triangular pieces, the apices of which are all directed towards the centre.

In the fœtus, the lens is of a reddish color, and soft; in the adult, it is transparent; and in old age, it becomes yellow, or of an amber color. The density of the lens gives to it a great refractive power, and its double convexity tends to draw the rays to a focus upon the retina.

The *vitreous humour*—occupies the two posterior thirds of the globe of the eye. It is fluid, perfectly transparent, and when contained within its membrane, forms a tremulous mass. This membrane enters so intimately into the composition of this part of the eye, that it may be described in two parts—the vitreous fluid, and the hyaloid membrane.

The *vitreous humour* mingles readily with water, does not coagulate by heat; its s. g. is 1·0009, and is therefore rather denser than the aqueous humour; but by chemical analysis, it is found to contain the same principles.

The quantity of this humour, 'is computed to be not less than one hundred grains.

The *hyaloid membrane*—not only surrounds the vitreous humour, but sends off innumerable processes into it, so as to divide the whole mass into cells, which communicate very freely with each other, so that if one cell be laid open, the whole fluid escapes, although but very slowly, in consequence of the minuteness of the cells. The anterior part of the hyaloid membrane, between the corpus ciliare and the crystalline lens, receives the ciliary processes in little grooves, producing therefore small projections, corresponding with the interspaces of the processes, which are marked by the pigmentum nigrum, in a striated manner, so as to give it the appearance of a disk of a flower, and is sometimes called the *corona ciliaris.*

The *use* of the vitreouos humour, is to give a general support to the tunic of the eye; and from its density being less than that of the crystalline lens, it tends to diverge the rays, and to form a larger picture upon the retina.

Physiology of the Eye.

The function of the eye is termed vision, or the sense of sight, and consists in the perception of the color, form, size, and distance of surrounding objects.

In order to comprehend fully the uses of the several parts of the organ of vision, it is necessary to make a few observations upon the nature, and properties of light; which is the intermediate agent between objects, and the eye, and the cause of those impressions upon which vision depends.

It is unnecessary to enumerate here all the phenomena and properties of light, as this rather belongs to the science of optics. Presuming, therefore, that the student has made himself acquainted with the elements of that science, from the "Lectures on Natural Philosophy," so ably given by my colleague, Mr. Barry, at Guy's Hospital, I shall touch upon those parts only, which directly bear upon the organization of the eye—and, first, of the nature of light.

Light has been admitted to be one of the imponderable substances, emanating from the sun, and all luminous bodies.

It is of two kinds, natural, and artificial. Natural light is that which is derived frem the sun, and fixed stars; and is so termed, to distinguish it from artificial light, which is derived from the combustion of inflammable substances, and from bodies heated to a state of incandescence.

To these sources, may perhaps be added some minor causes, such as, the state of bodies which, from certain chemical changes, become phosphorescent, or are naturally so, as the glow-worm and fire-fly; or which emit it in concurrence with electrical phenomena.

From either of these sources, light emanates in the form of rays, passing in straight lines, and with a velocity almost inconceivable.

It has been computed, that light travels two hundred thousand miles in a second, or twelve millions in a minute.

Light was, at first, considered as homogeneous; but Sir Isaac Newton discovered, that when a solar ray is made to pass through a prism, it is separated and refracted into rays of different colors, producing what has been termed the solar spectrum: this consists of an oblong image, consisting of rays of seven different colors; namely, violet, indigo, blue, green, yellow, orange, and red, blended into each other, the violet ray forming one boundary, and the red the other. These rays not only differ from each other in their color, but in their illuminating powers, and other circumstances. The greatest illuminating power resides in the lightest yellow, and palest green; the least, in the violet rays.

Dr. Herschel discovered that light also is accompanied by rays which excite heat, and that this power was greater in the red, and least in the violet rays; he also observed a spot, a little beyond the red, in the solar spectrum, where there was no light, but which was even hotter than the red itself; and inferred, that these rays must be less refrangible than those of light. Considerable variation has, however, been found in the situation of these calorific rays, apparently depending on the different powers of refracting caloric, in different transparent media.

Another curious effect, produced by the decomposition of light by the prism, is, the exhibition of its chemical properties in rays, which excite neither light nor heat, but cause rapid chemical effects—hence termed chemical rays.

These, according to Ritter and Wollaston, are most powerful just beyond the violet ray, and diminish from thence progressively to the green, beyond which they are wholly lost; hence the chemical rays are more refrangible than the luminous ones. Another remarkable property of light has been ascertained by Mrs. Somerville, to belong to the most refrangible or chemical rays; namely, that of imparting magnetic powers to needles, after an exposure of about two hours to a focus of the violent rays.

Certain bodies, as the diamond, and a compound named Canton's phosphorus, have the power of absorbing light upon being exposed to the sun's rays; and are capable of again emitting it for a time, when removed from their influence.

Rays of light, under common circumstances, pass in straight lines, and the bodies through which they pass, are termed media. Now these media, have a power of altering and modifying the course of the ray. This modification is called refraction, the light appearing as if bent or broken; and it depends upon two circumstances:—first, upon the density, secondly, upon the combustibility of the medium through which the ray passes. Thus, when a ray of light passes from a denser to a rarer medium, as from water into air, it is refracted from a line drawn perpendicular to the point of contact; and this refraction will be greater in proportion to the rarity of the fluid into which it passes. When, however, a ray passes from a rarer to a denser medium, as from air into water, a contrary effect ensues; the ray is drawn or attracted towards the perpendicular; and this in proportion to the density and combustibility of the medium.

It was formerly supposed, that this refraction was increased by giving a peculiar shape to the medium, if solid; but this is not the case; for lenses have merely the power of altering the disposition of one ray with respect to another, causing them to approximate, if convex, or recede from each other, if concave. Now a piece of glass with parallel surfaces, of equal density with a convex lens, would produce an equal degree of refraction: in the former instance, passing out or emerging in a direction parallel to that of their impingence, or in which they had passed in, owing to the density being the same throughout; in the latter case, their direction would be unequal, and they would tend to meet in a point or focus, owing to the density, and consequently the degree of refraction being unequal. The distance of this focus may always be determined by referring to the convexity of the lens: for if it be spherical, the focus will be at the distance of one quarter of its diameter; if for a double convex lens, the focus will be situated at the distance of the semi-diameter, of the sphere of which the surfaces of the lens form a part; and if for a plano-convex lens, it will be seen at double the distance of a double convex lens, or at the distance of the diameter, of the sphere of which the lens forms a part. While in concave lenses, their foci will be found bearing the same relation to the concavities of the spheres of which their surfaces form parts.

Concave lenses have the power of diverging the rays of light, as if they proceeded from a point anterior to the lens, and this in proportion to the degree of their concavity.

There are besides what are termed multiplying lenses, consisting of numerous facettes, each of which receiving the light at a separate angle, gives rise to a separate impression upon the retina, and the optical illusion of so many distinct objects.

So far with respect to light passing through transparent media. Now whenever a ray of light meets a body, which is not transparent, hence termed opaque, we find that it rebounds, or is reflected from the surface, and at an angle equal to that at which it falls; thus the angle of reflection is equal to the angle of incidence, and is opposed to refraction; though it may be observed, that a body which refracts light always in some measure reflects it.

Thus the modifications of light, are either transmission, reflection, or refraction; from which modifications, the color and appearance of all surrounding bodies depend. Thus, a body which transmits some rays, and reflects others, has a translucent appearance; such bodies as absorb all the prismatic colors but one, will appear visible by that color or modification which it reflects. It is curious that some bodies appear very different by the light which they reflect, from that which they transmit. Thus, gold by reflected light, is of a brilliant yellow, but by refracted, of a muddy green color.

The operation of light in producing the phenomena of vision, may be considered under two heads;—the perception of color and form, depending directly on the rays of light; and the perception of distance and size of objects, which is attributable to habit and experience, assisted in many instances by the sense of touch.

We will now trace the progress of a ray of light, through the different transparent structures of the eye, in its passage to the retina; and we shall find the organ a most beautifully constructed achromatic instrument, capable of adapting itself not only to the quantity, but the modification of the light which it admits.

Light reflected from opaque bodies, pass off in straight lines in every direction. Some of these rays impinge the transparent cornea; and it is believed that they undergo some slight change in passing through the moisture which covers its anterior surface; which may therefore be considered as essential to perfect vision.

The rays which strike the opaque cornea, are reflected, and according to the laws of optics, at the angle at which they impinged; and do not therefore interfere with the rays to be transmitted. The rays which impinge the transparent cornea, are refracted towards the perpendicular by the density of this structure; and by its convexity, they have a tendency towards a focus, so as to collect the rays in quantities corresponding to the size of the opening of the pupil: and, indeed, there is reason to believe that a reciprocal accommodation occurs between the refractive power of the transparent cornea, and the contraction or dilatation of the pupil; which, perhaps, we may account for, by the changes which must necessarily take place in the aqueous humour upon any motion of the iris. Thus, when the pupil contracts upon the membrane containing the aqueous humour, the fluid must necessarily be pushed forwards, and the transparent cornea rendered more convex, so as to alter the focus to the contracted dimensions of the pupil; and, on the contrary, when the pupil is large, there is more space through the pupil, for the fluid in its membrane; consequently, less pressure, and less convexity of the transparent cornea, and a proportionable divergent direction of the rays of the enlarged opening. Those rays, however, which do not pass through the pupil, are reflected from the iris, and denote its color.

The rays transmitted by the transparent cornea and aqueous humour, through the pupil to the crystalline lens, now undergo such changes as are produced by a double convex lens, modified, however, by the variety of density in its different layers, as well as by the means which the eye itself possesses of altering its own refractive power. All the light which passes upon the anterior surface of the crystalline lens, is not transmitted, part of it being reflected upon the posterior surface of the iris, where it is absorbed by the pigmentum nigrum. These rays seem to have a considerable effect upon the iris; for the rays which fall upon its anterior surface do not excite its contraction: but those reflected from the anterior surface of the crystalline lens, are absorbed by the pigmentum nigrum, and perhaps produce those particular effects upon the iris.

The rays which pass through the crystalline lens, converge so as to form a focus somewhat anterior to the surface of the retina. Were the two convex surfaces of the crystalline lens segments of the circle formed by the vitreous humour, the focus would then be in its centre; but as the posterior convexity is more prominent than the anterior, the focus cannot be in the centre of the vitreous humour. As soon as the rays emerge from the crystalline lens, they are passing from a denser to a rarer medium, and consequently diverge; by which divergence, a larger picture is presented to the surface of the retina.

In myopia there is a superabundance, in presbyopia a deficiency, in the refracting powers of the eye. In the former instance, the cornea is more prominent, and the crystalline lens more convex than natural; consequently, according to the laws of optics, the focus must be considerably anterior to its natural situation, though this will depend upon the distance of the object; thus, an object which is near, forming a greater angle, will have its focus still farther removed, so that it will be about its natural situation, Now it is obvious, that any thing which will increase the angle formed by an object, must produce the same effect; this is done by means of a concave lens. In presbyopia, we find the cornea and crystalline lens considerably flattened; so that according to the laws of optics, the focus will be prolonged beyond its natural situation. Here, therefore, any thing which will diminish the angle, will remove this defect: this is done either naturally, by removing the object to a greater distance, or artificially, by means of a convex lens, which, by converging the rays, must necessarily increase the angle at which they fall.

There is considerable difficulty in comprehending how the eye adjusts itself to the examination of objects at different distances; but it is evident that changes do take place; for if the eye be examined when a person abstractedly brings his mind to dwell upon the consideration of a minute object, the pupil will be seen to contract; and again, if the mind be directed to the imaginary examination of an extended landscape, the pupil will as immediately dilate. These phenomena seem to prove the necessity for some alteration in the adjustment of the globe of the eye; and as we know of no structure capable of being stimulated by the influence of the mind, but muscle, we have some right to infer, that the muscles are the principal regulators of the adjusting powers of the eye.

Let us therefore examine the attachment of these muscles, and we shall find, that they are not only capable of directing the whole organ; but also of producing such changes in its figure, as must materially affect its foci, and refractive powers.

With respect to the iris, no one has yet proved its muscularity; and there are as many reasons to believe it is composed of an erectile tissue, as to admit of its muscular contraction. The ciliary processes, also, yet open a considerable field for investigation to the anatomist, and physiologist. Of these structures, nothing has yet been satisfactorily given.

The pupil becomes motionless, and dilated, upon the division of the fifth pair of nerves; and, according to some anatomists, the same effect takes place after the division of the third pair; and sight is also lost upon the division of the optic nerve. It is evident, that the black pigment is of considerable utility, from the defective vision of albinos, in whom it appears to be deficient of color.

The picture formed on the retina, communicates the impression of distance to the brain, very much by the size of the picture, and the intensity of the light; thus, when two objects are placed at a distance, one behind the other, if that which is farthest from the eye receives the brightest light, it will appear the nearest.

I might here dwell upon the diversity of opinion with respect to the central foramen of the retina, placed as it is in the very centre of the axis of vision, whether or not it receives any impression from light. I might speak also of the points of entrance of the optic nerves, which are denied the power of the other parts of the retina, of receiving any impression from light. But these are subjects more for the direct consideration of the physiologist, and therefore should not be here discussed. I would, however, strongly recommend the perusal of Potterfield, on the eye; and the article on optics, by Dr. Brewster, in Reeces Encyclopedia.

The diseases of the eye, have been so ably and frequently written on by various surgeons, and in itself offers so very extensive a subject, that I shall not here enter upon it; but refer my readers to authors who have exclusively paid attention to this branch of surgery.

LECTURE XXXVII.

OF THE ORGAN OF HEARING.

Descriptive Anatomy of the Ear.

THE ear may be divided into three parts: the external or outer, which is for the purpose of collecting sound, and conveying it to the middle part, or cavity of the tympanum, which modifies it, and the internal part, the seat of sensation, and which is capable of appreciating sound.

Of the external part of the Ear, or Auricle.

The *auricle* in man, although furnished with small muscles, enjoys little or no voluntary motion; but in most animals is capable of both extensive and variable movements. It is situated on either side of the head, at the posterior part of the face, beneath the temple, and in front of the mastoid process of the temporal bone. Its figure is irregularly oval, being larger above than below, and having its greater diameter vertical. The circumference of the oval is free above, posteriorly, and below; while anteriorly, it is connected with the posterior part of the cheek.

Upon the external surface of the auricle, there are numerous elevations and depressions, which form a series of parabolic curves, for the purpose not only of collecting, but also for directing sound into the tympanum. These elevations and depressions have had names given to them, and therefore must be described.

The *helix*—forms the outer inverted rim, commencing in the middle of the auricle, above the opening of the meatus, and directing itself first forwards, then upwards and backwards, forms the circumference of the auricle, and terminates below at the commencement of the lobe. Its inferior extremity is somewhat bifid; its upper limb is connected with another eminence, which is termed the anti-helix, while the lower one is continuous with the lobe. A groove is produced between the helix and the other part of the auricle, which commences in the concha, takes its whole course, and has been termed the *fossa innominata,* which is more or less distinctly marked in different individuals.

The *anti-helix*—commences behind the helix, where it is rising upwards from the concha to form the superior part of the auricle, by two crura, the upper one of which is broader, and more obtuse than the lower or narrower one; they pass backwards, and uniting form one prominence, which is thicker than the helix, becomes thinner however as it passes downwards to terminate just above the anti-tragus, from which it is separated by a depression. The depression between the two crura by which the anti-helix commences, is termed the *fossa navicularis.*

The *tragus*—is a small triangular projection, which overlaps the opening of the meatus auditorius; the base of the triangle is directed forwards towards the cheek, with which it is continuous; and the apex overlaps the meatus. Above it is separated from the helix by a notch, and also below from the anti-tragus, which is posterior to it.

The *anti-tragus*—is in form very similar to the tragus; it is situated below the anti-helix, and behind the tragus, from which it is separated by a notch; its base is towards the lobe of the ear, and its apex is directed upwards, and slightly forwards towards the concha.

The *concha*—is a deep cavity, which is bounded above and behind by the anti-helix, and below by the tragus and anti-tragus; it is divided into two parts, an upper and a lower, by the commencement of the helix; the lower portion of the concha is continuous with the meatus auditorius.

The *lobe of the ear*—is a rounded soft eminence, void of elasticity, which forms the termination of the circumference of the auricle inferiorly; it does not appear in any way destined to perform any office in the function of the auricle.

The inner surface of the auricle, does not correspond in its convexity to the irregularities produced on the external surface; it is directed towards the head, having generally a slight inclination backwards, which would be more obvious but for the means adopted to prevent this tendency.

The parts which enter into the composition of the auricle, are the skin, fibro-cartilage, ligaments, and muscles.

The *skin*—is extremely thin, and firmly united to the fibro-cartilage by a most delicate cellular membrane, which never contains any fat, as that substance would have prevented the reverberation of sound; but at the lobe, which has nothing to do towards the function of hearing, there we find the skin containing a considerable quantity of adeps. The integument of the auricle, is also furnished with a great number of sebaceous follicles, and on the inner side of the tragus with some small hairs, which seem to be for the purpose of preventing light bodies floating in the atmosphere, from passing into the ear.

The *fibro-cartilage*—is the structure which constitutes the form of the auricle, and possesses flexibility enough to admit of its motions, and elasticity sufficient to maintain its form, and offer the best possible substance to admit of the reverberation of sound. It is this substance which gives the general figure to the auricle, and produces the various eminences and depressions which have been named; but it does not, however, continue throughout the whole surface of the organ, being in some situations deficient: for instance, it is wanting between the helix and the tragus, and also between the termination of the helix and the anti-tragus. It cannot, however, be properly said to be entirely deficient in these parts, as its fibrous tissue continues, but the cartilaginous does not. The lobe also has no fibro-cartilage entering into its composition.

The *ligaments* of the auricle—are three in number, and are for the purpose of fixing it to the side of the head; from their relative positions, they are termed superior, anterior, and posterior.

The *superior ligament*—passes upwards, from the inner surface of the concha, over the posterior extremity of the zygomatic arch, and is lost by expanding upon the temporal aponeurosis.

The *anterior ligament*—connects the auricle to the zygomatic process; it is attached to it, and to the base of the tragus, being continuous with its fibro-cartilage.

The *posterior ligament*—proceeds from the convexity of the concha, and is directed backwards to the mastoid process, with which it is connected.

The *muscles of the auricle*—are of two kinds; those which are destined to move the whole auricle, and those which act only upon its individual parts. They are all, however, but very indistinct, and by some anatomists the existence of the second class is entirely denied; but as they are frequently found, it is right to describe them, and to consider their absence as the result of disease, and the tenacity with which children's ears are kept confined to the side of the head, for fear they should be directed forwards, as intended by nature.

The muscles common to the auricle, are three in number.

M. attollens aurem—is of a thin triangular figure, arising from the temporal aponeurosis, from whence its fibres descend, converging as they pass downwards to be inserted into the superior part of the inner convex surface of the concha. The external surface of this muscle is covered merely by the skin; its internal surface covers the aponeurosis of the temporal muscle; its anterior edge is longer, and more oblique than its posterior edge.

Use.—To elevate the auricle, and at the same time to draw it forwards; by which action it enlarges the concha, and opens the meatus auditorius externus.

M. auricularis anterior—is smaller than the last-described muscle, and arises from the temporal aponeurosis, at the posterior extremity of the zygomatic arch, from which point its fibres pass backwards to be inserted into the inner surface of the helix; above, it is bounded by the last-described muscle; while its lower edge has immediately below it, the zygoma.

Use.—To assist the attollens in drawing the auricle upwards and forwards.

M. auricularis posterior, vel retrahens auriculam.—This muscle is usually composed of three or four distinct bundles, which proceed forwards from the anterior edge of the mastoid process, to be inserted into the inner surface of the lower part of the concha, by distinct aponeurotic fibres.

Use.—To draw the auricle backwards, and to contract in some measure, the opening of the meatus externus.

The muscles proper to the auricle, are five in number.

M. tragicus—is the largest of the five, and may almost invariably be found; it is of a triangular form, corresponding to the figure of the tragus; it arises from the base of the tragus, and passes forwards, the fibres converging to be inserted at the apex of that body.

Use.—To draw the apex outwards and backwards, and to enlarge the opening of the meatus externus.

M. anti-tragicus—passes from the upper part of the fibro-cartilage, supporting the anti-tragus, and fills up the space or notch between the anti-tragus and anti-helix, to the fibro-cartilage of which it is also connected.

Use.—Either to direct the apex of the anti-tragus outwards, by which action it enlarges the opening of the meatus, or else to draw downwards the anti-helix; and in this action, perhaps, it renders the whole auricle a better vibratory medium.

M. helicis major—is attached to the helix major, just where it is passing above the tragus; from whence it passes downwards to be inserted into the fibro-cartilage of the helix, where it arises from the concha.

Use.—To render the commencement of the helix major tense, and to deepen the concha.

M. helicis minor—is situated behind and below the preceding muscle, within the concha, being attached to the commencement of the helix major.

Use.—To assist in increasing the concavity of the concha.

M. transversus auriculæ—is placed upon the inner or convex surface of the auricle; it arises from the prominence produced by the fossa innominata, and is lost upon the convexity of the concha.

Use.—To diminish the depth of the concha, and antagonize the helices muscles.

The *arteries* of the auricle are dervived from the ramulus a. auricularis posterior, and ramulus a. temporalis, of the external carotid ramus.

The *nerves* spring from the auricular ramus n. of the third division of the fifth pair, from the posterior auricular ramus of the portio dura, or seventh pair, and from auricular filaments from the cervical plexus.

Its *absorbents* pass to glands which are placed behind the temporo-maxillary articulation, upon the outer surface of the sterno-cleido mastoideus muscle.

The *meatus auditorius externus*—leads from the auricle to the cavity of the tympanum, and is placed between the mastoid process of the temporal bone, which is behind it, and the temporo-maxillary articulation in front of it, the zygomatic process above it, and the vaginal and styloid processes below it. In the adult subject, it is from eleven to twelve lines in extent, but does not pass in a straight direction, having an obliquity forwards as it passes inwards. It is also curved in this direction in such a manner that its calibre presents a convexity upwards, and a concavity downwards. Its inner extremity terminates obliquely, as if truncated from above downwards, and from without to within, so that its inferior surface is longer than its superior. The meatus auditorius is formed of skin, fibro-cartilage, ceruminous glands, and bone.

The *skin*—is a continuation of the integuments of the auricle passing into the meatus, and forming upon the external surface of the membrana tympani, a *cul de sac,* from which it is very readily separated by a putrifactive process. As it first enters the meatus, it is of the same thickness as on the auricle, but becomes more and more attenuated as it approaches the tympanum. In its course it is furnished with very small hairs, which are most evident at the commencement of the meatus. It is also perforated by a number of small openings, which are the mouths of the excretory ducts of the ceruminous glands. These are principally situated in the upper and posterior part of the meatus.

The *fibro-cartilage*—is continued from that of the tragus, and also from the inferior part of the concha, forming only a portion of a canal, the interspaces being filled up so as to complete the circle by fibrous tissue; thus connecting the soft with the bony structures of the meatus. The spaces between the fibro-cartilaginous portions, which are filled up by the fibrous tissue, have been termed the fissuræ of Santorini; the larger of which is at the upper and back part of the meatus.

The *ceruminous glands*—are placed between the skin and the fibro-cartilage, imbedded in cellular membrane; they are most numerous in the upper, and back part in the fissure of Santorini; they are of a reddish yellow color, each being furnished with an excretory duct, to convey their peculiar secretion into the meatus. This secretion is a thick bitter fluid, but slightly soluble in water, and according to Vauquelin, contains an oil, albumen, and coloring matter.

Of the Tympanum.

The *tympanum*—or middle portion of the ear, is that cavity placed between the meatus auditorius externus, and the labyrinth.

The tympanum is very irregular in its form, but it presents parts of so much importance to the function of hearing, as to render it quite necessary to subdivide this cavity into different surfaces or walls. It presents, therefore, an external wall, filled by the membrane of the tympanum, and opposed to the meatus auditorius externus; an internal wall, which separates the cavity of the tympanum from the labyrinth; an anterior wall, which is bounded by the eustachian tube; a posterior wall, opposed to the mastoid process of the temporal bone; a floor, bounded by the carotid canal, and fossa jugularis; and a roof, which is bounded by the opening to the mastoid cells, which pass upwards, backwards, and downwards, to the mastoid process.

The *external wall*—admits of little farther description than that of the membrana tympani, which principally composes it; unless, indeed, we describe the rim of bone which receives that membrane. This aperture, or rim of bone, forms three-fourths of an oval figure; the upper fourth not presenting a continuation of the oval, but an irregular horizontal line, passing from before backwards. The principal irregularity in this line is produced at its upper, and anterior part, for the purpose of containing a membrane, which has been discovered by my friend Mr. Shrapnell; and of which I shall give a short description, with the rest of the membrana tympani.

The *membrana tympani*—forms by far the larger portion of the outer wall, presenting an obliquity from above downwards, and from without to within, so as to form a very acute angle with the inferior surface of the meatus auditorius externus.

The membrana tympani, is covered externally, by the skin of the meatus auditorius, and internally, by the lining mucous membrane of the cavity of the tympanum; while the middle fibrous tissue, is composed of radiating fibres, emanating from the manubrium of the malleus, to pass to the groove which is lodged in the bony ring just described. This membrane then, in fact, admits the manubrium of the malleus, so that the upper two thirds of the membrane are divided into two by this process of bone.

From the upper and anterior part of the membrana tympani, and occupying the irregularity which has been described, in the horizontal upper fourth of the oval rim of bone, there is a membrane differing from the larger portion, in its structure, in the distribution of its fibres, in the plane of its surface, as well as in not being received into a groove.

These circumstances, prove the necessary physiological difference between this portion and the rest of the membrana tympani; the latter being in every way adapted, from its tension, to vibrate; while the former is, from its flaccid state, constituted, rather to annihilate, than to propagate vibration. This portion of the membrane, Mr. Shrapnell has termed the membrana flaccida:—a name aptly chosen, as it points out at once, that the membrana tympani is not only for the purpose of increasing, but under certain circumstances of diminishing the force of vibration. The particular direction of the plane of the membrana tympani, will be mentioned when describing the manubrium of the malleus, upon its attachment to which it depends.

The *inner wall*—presents the following important parts.

The *fenestra ovalis*—has its long axis placed horizontally, and is situated in about the centre of the inner wall, but rather more to its upper and posterior part. The upper part of this oval foramen, has passing over it *a projection*, which marks the course of the canal of Fallopius; below the fenestra, there is a projection of bone termed the *promontory*, beneath which, and rather posterior to the centre of the fenestra ovalis, is situated the—

Fenestra rotunda—which is so overlapped by the promontory, as to require the temporal bone to be held in a particular direction to bring it into view. At the junction of the inner with the posterior wall of the tympanum, *foramina* are found, which admit of the passage of nerves from the canal of Fallopius, as well as from a distinct foramen, through which a filament passes from the glosso-pharyngeal nerve. At the junction of the anterior and inner wall, the two surfaces concur in forming passages for the entrance of the eustachian tube, and the tensor internus muscle.

The *anterior wall*—in the dry bone, presents little to be observed, beyond the spaces for the eustachian tube, and tensor tympani muscle; there is, however, above this a small opening, which leads to the fissura Glasseri, to transmit the chorda tympani nerve, and admit the laxator tympani muscle.

The *posterior wall*—is almost a cribriform plate of bone, some of the foramina admitting of the nerves to enter the tympanum from the canal of Fallopius, and others leading into the mastoid cells. Upon this wall is to be observed, pointing to the long axis of the fenestra ovalis, a hollow projection of bone, which is termed the *processus pyramidalis*, and which gives attachment to, and contains the musculus stapedius. On the outer side of this pyramid being nearer to the outer than the inner wall, it is, that the foramen is situated, for the passage of the filament of the glosso-pharyngeal nerve; and above the pyramid nearest to the inner wall, small foramina are placed, which admit of the nervous filaments from the canal of Fallopius.

The *floor of the tympanum*—furnishes foramina for the entrance of nervous filaments from the carotid canal, which, with the fossa-jugularis, forms its boundary.

The *roof of the tympanum*—presents an opening of considerable size, which leads backwards and downwards, into the mastoid cells, but nothing further worthy of observation.

The *eustachian tube*—which has been described as opening into the anterior part of the cavity of the tympanum, leads from the upper part of the pharynx to the ear, and is termed the iter a palato ad aurem. It is composed of bone, fibro-cartilage, and membrane, is about two inches in length, and in its course from the ear to the pharynx, is directed forwards, inwards, and downwards, terminating near the inner lamina of the pterygoid process of the sphenoid bone, by a large aperture, the sides of which, however, so approximate as to form it into a kind of fissure.

The *bony* part of the eustachian tube, is placed above the carotid canal, and on the inner side of the fissura Glasseri, in the angle formed by the junction of the squamous with the petrous portion of the temporal bone. The *fibro-cartilaginous portion* does not form the whole circumference of its calibre, but only the inner, and anterior part of the outer wall of the canal; it commences by being attached to the bony irregularities of the eustachian tube; and as it passes forwards, towards the pharynx, it assists in filling up the foramen lacerum basis cranii anterius.

The fibro-cartilage of the eustachian tube—gives attachment to the pterygoideus internus, circumflexus palati, levator palati, and the tensor tympani muscles.

The *membranous portion* of the eustachian tube, forms the principal part of its outer parietes, and unites the two edges of the fibro-cartilage—thus completing the canal. It seems to be a continuation of the mucous membrane of the pharynx, but much lighter in color, as it approaches the ear; and having gained the tympanum, its texture and secretion are quite altered, so as to have led. some anatomists to deny the lining of the tympanum by mucous membrane. At its pharyngeal extremity, the mucous membrane is much thicker and redder, and furnished with numerous mucous follicles.

The *ossicula auditus*—or bones contained in the tympanum, are four in number; and are termed the malleus incus, os orbiculare, and stapes.

Malleus—is placed on the superior part of the inner side of the membrana tympani, and is furnished with a head, neck, processus gracilis, and the manubrium. The *head* forms the upper part of the bone, is ovoid, presenting posteriorly, a double, smooth, articulatory surface, to be articulated with the incus; this surface is divided into two by a slight non-articulatory process. The *neck* is very small, being scarcely more than a line in length, and unites the head to the manubrium; it is situated at the upper part of the membrana tympani, and gives attachment to a delicate lengthened process, which is termed the *processus gracilis*. This process, passes horizontally outwards and forwards, to traverse the fissura Glasseri, and gives attachment to the laxator tympani muscle.

The *manubrium*—of the malleus, is narrower than the neck, and passes obliquely downwards, forwards, and outwards, so as to be connected with the membrana tympani, terminating by a thin rounded extremity, which corresponds to the junction of the middle with the inferior third of the membrane. From the upper and outer part of the manubrium, there projects a short process, which is sometimes termed the *processus obtusus,* which is attached by ligament to the bony rim of the outer wall of the tympanum, and forms a fulcrum for the motions of the malleus. This little process, close to its origin from the manubrium, gives attachment to the tensor, or internal muscle of the malleus.

Incus—is situated behind the malleus, and to its inner side, nearer to the mastoid cells. It presents a body, and two crura, which are separated from each other, and are of unequal length.

The *body*—or head, is directed forwards, and slightly upwards, and presents a concave, semilunar, articulatory cavity, which is divided into two surfaces to receive the head of the malleus.

The *superior crus*—is the shorter, is strong and thick, and is directed downwards and backwards, to be connected by ligament to the posterior wall of the tympanum, close to the openings of the mastoid cells. This crus forms another fulcrum for the motions of the bones of the ear.

The *inferior crus*—is much the longer, and is directed downwards, forwards, and inwards, to be articulated to the os orbiculare, so that its inferior extremity on its inner side presents a small articular surface; in this course, the inferior crus of the incus runs nearly parallel with the manubrium of the malleus.

Os orbiculare—is a small round bone, placed between the inferior crus of the incus, and head of the stapes; it presents, therefore, an inner, and an outer articular surface, for these two bones.

Stapes—is situated between the os orbiculare, and the fenestra ovalis, the long axis of its base being placed horizontally; it is divided into its head, neck, two crura, and base.

The *head*—is directed outwards, and presents a small concave articular surface, to receive the os orbiculare; it is connected to the rest of the bone, by a small *neck*, which results from the union of the two crura, the neck giving attachment to the stapedius muscle. The crura are placed horizontally, one before the other: the *anterior crus*, is longer than the *posterior*, and both of them are curved; they pass to be attached to the base, forming a space, of a parabolic figure, which is filled up by a membrane.

The *base*—forms the inner part of the bone, is a broad and thin plate, of an oval figure, its long axis being placed horizontally, and applied to the fenestra ovalis, which it imperfectly closes, but is connected to its circumference by the membranes of the tympanum, and vestibule.

Muscles of the Ossicula.

M. tensor tympani, vel internus malleus—arises from the petrous portion of the temporal bone, and the osseous canal of the eustachian tube; from this point, it takes its course backwards and outwards, parallel to and above the eustachian tube, enclosed in a distinct canal; when it reaches the cavity of the tympanum, it becomes tendinous, and passes through a hamulary process, at the termination of the canal, and taking its course slightly upwards and outwards, to be inserted into the processus obtusus of the malleus.

Use.—To draw the manubrium of the malleus, and consequently the membrana tympani forwards, upwards, and inwards—thus rendering it tense.

M. laxator tympani, vel malleus externus.—This muscle arises from the little styloid process, at the extremity of the spine of the sphenoid bone, and from the cartilaginous portion of the eustachian tube, and then passes backwards to enter the glenoid fissure, and thus gain the cavity of the tympanum, where it is inserted, by passing slightly outwards, into the processus gracilis of the malleus.

Use.—Is not, as usually described, to relax the tympanum; this must be obvious at once to any one who examines the direction of its course, and point of attachment to the malleus, which must produce a motion of the membrane, similar to the last-described muscle; and consequently, in concert with it. It may properly enough, therefore, be called the m. tensor tympani externus.

M. stapedius—is a delicate round muscle, contained in the cavity of the processus pyramidalis, from the interior of which it arises; its tendon passes out of the foramen at the apex of the pyramid, to be inserted into the posterior crus of the stapes, close to its neck.

Use.—To draw the head of the stapes backwards, and elevate the anterior extremity of its base; it may also act upon the whole chain of the ossicula, rendering them tense.

The tympanum is lined by membrane, which is continued from the pharynx, and is therefore a portion of the gastro-pulmonary mucous membrane; but in different parts of its course along the eustachian tube, and more particularly in the cavity of the tympanum itself, its structure and secretion differ so much, as frequently even to lose the character of mucous membrane, and has led some physiologists to deny its existence in these parts.

The Labyrinth.

The *labyrinth*—is the third, or internal portion of the ear; it is placed between the tympanum, and the meatus auditorius internus, and is composed of the vestibule, semi-circular canals, and cochlea.

The *vestibule.*—In prosecuting the dissection of the ear according to the plan I have here adopted, I should wish first to direct the student's attention to the precise position of the vestibule, which is a cavity placed immediately to the inner side of the fenestra ovalis. This cavity is of an irregular figure, about the size of a swan-shot, presenting strong parietes in every direction; and the following foramina opening into, and from it.

The first opening, is the one we have already described from the tympanum, the fenestra ovalis, which forms the greater portion of the outer wall, or boundary of the vestibule. Posteriorly, there are five openings from the semi-circular canals, the relative position of which will be immediately described. Upon the posterior part of the inner wall, a sixth is found, the entrance of the aqueductus vestibuli, which, externally has already been described to open immediately behind the foramen auditivum internum. The last or seventh opening, is the scala vestibuli, which leads down to, and indeed assists in forming the cochlea. This opening is placed in the inferior part of anterior wall of the vestibule There might also be mentioned some very minute foramina, which give passage to the filaments of the portio mollis.

Of the Semi-circular Canals.

These are three in number, placed within the substance of the petrous portion of the temporal bone, above and behind the vestibule. Their direction differs; and with respect to the long axis of the petrous portion of the temporal bone, they may be named the vertical, the oblique, and the horizontal canal.

The *vertical*—usually called the superior vertical canal, is intermediate in size, between the oblique and the horizontal; it presents an internal and external crus, and its convexity faces immediately upwards. It is hollow, as its name would imply; and its outer crus opens upon the outer side of the roof of the vestibule, near to the posterior wall. Its inner crus forms a common opening with the superior crus of the oblique canal on the internal wall.

The *oblique canal*—is placed on the inner side of the other two canals, and is nearly parallel with the posterior surface of the petrous portion of the temporal bone; its convexity is directed towards the mastoid process of the temporal bone; its superior crus opens in common with the internal of the vertical, and its inferior near to the commencement of the scala vestibuli.

The *horizontal canal*—is the smallest of the three, and is placed below,—each crus opening separately into the vestibule. The outer crus opens immediately below the outer crus of the vertical canal, and the inner opens between the two crura of the oblique canal. The convexity of this canal is directed backwards, towards the mastoid process of the temporal bone.

Where these semi-circular canals terminate in the vestibule, they each enlarge at one of their extremities,—forming what is termed the ampulla.

The ampullæ of the vertical and the horizontal canals, are formed by their outer crura; and in the oblique canal, by its inferior crus. The continuation of these ampullæ, seem to form a large proportion of the cavity of the vestibule; and that of the inferior crus of the oblique, may be traced as continuous with the scala vestibuli.

The *cochlea*—forms a part of the labyrinth; but it may also be said, in some measure, to belong to the cavity of the tympanum, below, and to the inner side of which it is placed. The cochlea is made up of two canals, separated from each other by a spiral process of bone, which are winding around a central pillar called the modiolus, and are all enclosed in the substance of the petrous portion of the temporal bone.

The first canal to be described, is the *scala tympani*—which commences from the fenestra rotunda, passing downwards, forwards, and inwards, and taking the two turns and a half around the modiolus, it terminates at the apex of that pillar of bone in an opening. The roof of this canal is in its whole course formed by the lamina spiralis.

Lamina spiralis—commences from the vestibular side of the inner wall of the tympanum, between the fenestra ovalis, and the fenestra rotunda, separating those foramina from each other as the promontory does upon the inner wall of the tympanum; from that point it passes forwards and inwards, until it meets the modiolus, around which it takes two turns and a half; and at the apex or outer extremity of this pillar, it projects a little over the opening of the scala tympani, and terminates in what is called the hamulary process. From the anterior part of the vestibule, and consequently above the lamina spiralis, the *scala vestibuli* commences. This canal passes downwards and forwards, until it meets with the modiolus, around which it takes two turns and a half, terminating at the apex of the modiolus, above the hamulary process of the lamina spiralis.

The *modiolus*—is a pillar, which crosses at right angles the petrous portion of the temporal bone, extending from the termination of the foramen auditivum internum, obliquely outwards, to the cupola of the cochlea. The modiolus is conical in its form, its base is towards the foramen auditivum internum, and is cribriform for the passage of the portio mollis. The apex which terminates the modiolus, as well as the scala vestibuli, the scala tympani, and the lamina spiralis, are all overlapped by the concave portion of bone termed the *cupola,* in which there must therefore be placed two openings—one, the termination of the scala tympani, and the other, the termination of the scala vestibuli. If a fluid were injected from the vestibule into the cochlea, it would fill both scalæ, but not pass into the cavity of the tympanum, as the fenestra rotunda is closed by a membrane.

The bony cavities of the labyrinth are lined by a very delicate membrane, which proceeds from the cavity of the vestibule into all the semi-circular canals, forming within them smaller canals than the bones themselves; and from the anterior part of the vestibule, it also passes down the scala vestibuli, covering the upper surface of the lamina spiralis; it then proceeds to the hamulary process within the cupola, winds around it to gain the scala tympani, lining it in a similar manner.

It should be remarked, however, that the lamina spiralis in separating the scalæ from each other, does not form a complete bony partition; one half being membranous, but that part of the lamina spiralis which is next to the modiolus, is bony. The cavity of this mambrane, contains a fluid which is somewhat viscid, fills all the cavities of the labyrinth, and is opposed to the ultimate and sentient extremities of the portio mollis.

From the scala tympani, just within the membrana fenestra rotunda, a minute opening, named the *aqueductus cochleæ*, leads to the base of the petrous portion of the temporal bone, where it opens under the dura mater, between the fossa jugularis and carotid canal.

The nerves which supply the organs of hearing, are the portio dura, portio mollis, glosso-pharyngeal, and sympathetic.

The portio dura and the portio mollis together pass into the foramen auditivum internum, at the bottom of which they separate—the portio dura to enter the canal of Fallopius, and the portio mollis to pass through the cribriform openings of the labyrinth. But just before these two nerves separate, according to the recent dissections of my friend Mr. Shrapnell, they decidedly communicate with each other; which circumstance has been denied by most anatomists. The portio dura, soon after it has entered the canal of Fallopius, receives the superior nervous ramulus from the ramus vidianus of Meckel's ganglion, which enters at the foramen innominatum; and these nerves also unite with each other, and together proceed along the canal of Fallopius, in a direction upwards and backwards, over the inner wall of the tympanum, and immediately above the fenestra ovalis; it is then directed downwards and backwards to gain the foramen stylo-mastoideum, where it passes out to be distributed upon the face. In this course, however, immediately behind the fenestra ovalis, and at the base of the processus pyramidalis, there is a foramen which leads from the canal of Fallopius, and through which a nerve passes into the cavity of the tympanum: this nerve has always been hitherto described as the chorda tympani, and taking its course forwards between the manubrium of the malleus and the long crus of the incus, to gain the fissura glasseri, and to be ultimately connected with the ramusculus gustatorius of the ramus n. maxillarius inferior, of the third division of the fifth pair.

Mr. Shrapnell, however, describes the nerve which passes out of this foramen, as dividing into two or three filaments—one passing upon the promontory, to unite with filaments from the carotid canal; another, which passes to the membrane of the stapes; and a third, to the stapedius muscle: while the chorda tympani, he considers as emanating from the glosso-pharyngeal nerve, entering a foramen immediately anterior to the stylo-mastoid foramen, passing up in the direction of the canal of Fallopius, as far as the posterior wall of the tympanum, upon the outer side of which it opens close so the junction of the straight portion of the bony rim of the membrane of the tympanum with the posterior wall. Through this foramen, the filament of the glosso-pharyngeal nerve passes, and becomes the chorda tympani, taking the course before described.

I think it right, knowing the numerous preparations Mr. Shrapnell has made in the examination of this question, to take this early opportunity of publishing his opinions; although I have not yet satisfied myself of the propriety of his describing the chorda tympani as a branch from the glosso-pharyngeal nerve. But as he is now preparing a work upon the anatomy of the ear, the result of his dissections will soon be laid before the public. It is quite clear, that the nervus innominatus, glosso-pharyngeal, filaments from the portio dura, and from the superior cervical ganglion of the sympathetic nerve, all concur in supplying the parts within the tympanum, and form intimate junctions with each other.

The portio mollis within the meatus auditivus internus, divides into two rami; one passing to the cochlea, the other to the vestibule; the latter enters the vestibule by three ramuli, and is distributed as described, page 241.

Physiology of Hearing.

The ear perceives sounds, and distinguishes their variety, distance, and intensity: sound bearing the same relation to the ear and its perceptions, that light does to the eye in vision. It will be necessary, in order to understand the function of the several parts of the ear, to examine and make a few observations upon the nature and properties of sound.

Sound is the result of a vibratory motion among the particles of elastic bodies, which motion is caused by exterior forces, and is capable of being communicated to surrounding bodies, and of being propagated by them.

Thus, the air is the general medium of communication between sonorous bodies and the ear; but as solids also communicate sounds, they also may be made the means of communication, either, directly, through their substance, or by being hollowed so as to concentrate the vibrations—thus increasing the effect of those communicated by the air. The vibratory motion of sounds, may be either slow, or rapid, producing what has been termed acute and grave sounds.

It has been calculated, that the gravest sound consists of thirty-two vibrations in a second, and the most acute, of twelve thousand; these limits constituting the range of appreciable sounds.

Appreciable sounds or tones, are found to bear a certain relation to each other, constituting harmony. Thus, a distinguishable sound or tone of double the number of vibrations of another, has an harmonious relation to it, and is termed its octave; while the intermediate vibrations between one octave and another, produce seven appreciable sounds; these constitute the gamut, or diatonic scale of music, distinguished in musical writing as the notes of the octave, and are lettered a. b. c. d. e. f. g., and are designated by the names ut, re, mi, fa, sol, la, si; the further consideration of which, belongs to the science of music.

Sounds which are not appreciable by the ear, from the number of vibrations, are termed noises.

Besides the tones or notes of the gamut, the ear distinguishes the expression or timbre, depending upon the nature of the sonorous body; thus, when wood or metal is struck, or in the still more familiar instance of the voice, the ear instantly distinguishes each variety of expression.

Sound travels, or is propagated through bodies with various degrees of rapidity. Thus, in air at the rate of one thousand one hundred and thirty feet in a second, or about thirteen miles in a minute; and according to Cladni, in water four thousand nine hundred, in wood twelve thousand feet in a second; it however loses its force or intensity in exact proportion to the square of the distance from whence it emanates; and all sorts of sounds are propagated with the same rapidity, and without change. When sound meets a body that prevents its passing, it is reflected in angles equal to those of incidence: and the impression on the ear of reflected sound, is termed echo. Reflected sounds are capable of concentration, and will be heard more distinctly at the point of focus.

We should now examine how well the organs of hearing are appropriated to the collection, modification, and perception of sound.

The external ear is placed in the most advantageous situation to be impressed by the air, when influenced by the motions of the particles of a sonorous body Its form and tissues admit of the impinging air being collected and reflected so as to form a focus upon the meatus auditivus externus: this is produced by the parabolic curves of the eminences and depressions of the external ear. In most animals, the auricle enjoys a considerable degree of motion, so as to be directed either towards or from a sound, as it may either be agreeably or too violently impressed—making this part of the organ a safeguard to the more delicate structures. Man, however, possesses but little of these powers, although more perhaps than at first view we are led to expect; for we have reason to believe, that the external ear performs its part in modifying an intense sound, when by the will it is prepared for any violent concussion.

The undulating air thus collected by the auricle, and conveyed into the meatus auditorius externus, impinges the membrane of the tympanum, which becomes affected, and as is believed by some physiologists, is in itself capable of modifying the degree of sound it should communicate to the ossicula auditus. The late Sir Everard Home was of opinion, that a muscular structure entered into the composition of this membrane; while it is generally believed, that this membrane is only capable of modifying sound by the action of the muscles of the ossicula. From the membrane of the tympanum, some doubt may arise as to the means by which the sound is conveyed to the labyrinth. By some it is believed, that the small bones alone communicate the sound; by others, that the air contained within the tympanum is the means by which it is conducted: it is right, perhaps, to consider that each assists in the function of the tympanum; as either destruction of the bones, or the absence of air from the tympanum from diseases of the eustachian tube—each causes deafness. Deafness, however, occurring from obliteration of the eustachian tube, does not necessarily prove that the air contained within the tympanum is for the purpose of conveying sound: for its absence may produce deafness, by the outer atmosphere pressing so forcibly upon the membrane of the tympanum, as to prevent the motion of the small bones.

When the fingers are pressed into the meatus, and the outer ear thus closed, hearing is rendered imperfect only, in consequence of the communication being cut off from the external air; but yet certain sounds, such as rumbling noises, are still distinct; which seems to prove, that there are different means of conveying sounds to the internal ear, by which the nerves may be sensibly affected, whether it be transmitted through the organ of hearing itself, or through the substance of the body.

The small bones of the ear, are so articulated and influenced by muscles, as to form a chain of communication between the membrane of the tympanum and the base of the stapes, which is in contact with the membrane lining the vestibule. Whether these bones actually convey the sound, or only modify its degrees of intensity, is a subject not yet clearly understood by physiologists. The sound having reached the labyrinth, perhaps partly through the medium of the bones impressing the vestibule, partly by the air in the tympanum impinging the membrane of the fenestra rotunda, and probably also assisted by the stapedius muscle, which prepares the labyrinth for the due perception and appreciation of the most delicate varieties in sound. The mode by which the stapedius muscle assists in this function, I shall leave the description of to my friend Mr. Shrapnell, the discoverer of its particular attachments. Whatever may be the means by which sound is conveyed to the labyrinth, little is known how its intricate structures are capable of communicating its influence to the sensorium.

Practical Remarks.

The ear is liable, as would naturally be inferred from the delicacy of its structure and variety of its tissues, to numerous diseases; the slightest of which interfere with their function.

The diseases of the auricle are most easily treated, because they are more readily detected, and remedies can be more readily applied. Malformation, however, sometimes leads to defective hearing; thus the auricle may be wanting entirely, or its form may be so unnatural as to render it ill fitted to convey sound to the meatus; under these circumstances, acoustic instruments are required. The integument sometimes closes the external opening of the meatus, requiring to be punctured for the purpose of establishing a passage; this, however, is not always effected, as the meatus is occasionally filled up entirely by a fibro-cartilaginous tissue; under which circumstances, the operation must necessarily fail.

Sir Astley Cooper, in his lectures frequently mentioned two cases of malformation of the meatus. In the one, a servant of Dr. Girdleston, of Yarmouth, at the age of fourteen years was restored to hearing, by puncturing the skin which covered the meatus: while in the other, a Scotch boy who called at his house, the removal of the skin produced no good effect—the meatus being filled up. The meatus itself is sometimes so small, as to interfere with the function of hearing; for which no remedy has been found effectual, although sponge tents, and other modes of dilation, have been attempted. When the meatus is the subject of inflammation, it is always accompanied with a great degree of general excitement; and the strictest antiphlogistic plan should be immediately adopted, to prevent the formation of matter. This, however, does occasionally occur, producing an aggravation of symptoms, and having a tendency to evacuate itself, either into the meatus, or between the auricle and the mastoid cells. As soon as matter can be detected, an opening should be made. When the abscess opens into the meatus, granulations of a peculiar kind form, depending upon the structure of the part; these are sometimes mistaken for polypi; and fatal consequences have ensued from attempts to remove them with forceps. Mild astringent injections, with alterative and tonic medicines, are the means to be adopted in such cases. The diagnostic mark by which these granulations may be distinguished from true polypi, is to be gained by desiring the patient, while closing the nose and mouth, to attempt to blow; when, if it be polypus, air will rush through the membrana tympani by the side of the polypus, as it invariably arises from the cavity of the tympanum, and cannot therefore make its appearance within the meatus without absorption of that membrane.

Extraneous substances, indurated cerumen, and small excrescences from the cuticle of the meatus, should be carefully removed.

Diseases of the Tympanum

When inflammation first begins, considerable pain is produced, attended with slight deafness, pain in the head, and even sometimes delirium. The patient should immediately be bled, and a few leeches also applied around the ear, saline aperients administered, and indeed the most strict antiphlogistic regimen prescribed. These means may not always be effectual, and matter may form, and make its escape through the membrana tympani; the discharge is ichorous, sometimes tinged with blood, and imparts a yellow tinge to a silver instrument. Great care must be taken in the local treatment of this disease; the mildest astringent injections should be used, with the adoption of the antiphlogistic regimen before prescribed.

Several instances have occurred of fatal consequences, produced by too strong injections. Matter has been found in the cerebellum, and between the dura mater and the temporal bone, the occurrence of which has been frequently recorded; and some have come under my own notice. This discharge of pus is sometimes followed by polypi; these must be removed by the most gentle mechanical means that can possibly be adopted. Inflammation of the tympanum occasionally produces the destruction of the ossicula auditus—generally indicated by a fœtid discharge, and greater degree of deafness than in the other instances. Such cases must be treated rather by constitutional than by local remedies, although mild astringent injections will be found beneficial.

Obstruction of the eustachian tube, frequently arises from syphilitic ulcers, cynanche, or polypi of the nose; deafness is the consequence of this disease, which may be detected by the inability to inflate the membrane of the tympanum; if this effect has been produced by exposure to cold, producing inflammation, it is usually removed by those remedies which relieve the cause; if by polypi pressing on the tube, their removal also effects a cure; if by cicatrix, instruments should be passed through the nose, either to dilate or puncture the commencement of the eustachian tube: but as all these means have in some instances failed, Sir Astley Cooper recommends puncturing the membrane of the tympanum, which immediately restores the patient to hearing. The good effect is, however, but of short duration; for the opening soon closes again, or the membrane is wholly destroyed: either of which circumstances places the patient much in the same situation as he was before the operation. In two or three instances, however, the operation has proved permanently successful.

Of the diseases of the labyrinth, leading to deafness, little or nothing is known; violent concussion, altered function of nerve, inflammation of the lining membrane, may all tend to produce deafness, without leaving any means by which the cause of loss of hearing can be detected: but the local symptoms produced by any of these causes, must be alleviated by such remedies as the circumstances indicate, as they depend principally upon the general health of the patient.

LECTURE XXXVIII.

DESCRIPTIVE ANATOMY OF THE ORGAN OF SMELL.

The bony parts of the nose, which are destined to protect the more delicate structures, which enter into the composition of the organ of smell, have already been described; *vide* Vol. I. page 72; but the cartilages, and softer parts, are now to be considered.

The nose, with respect both to its bony and soft parts, although varying much in form, may be described as a pyramidal eminence, reaching from the centre of the forehead to the upper lip, and bounded on either side by the eyes, and cheeks. Its lateral surfaces are flattened, and are posteriorly connected to the cheeks by a deep groove marking the separation of the alæ, at the lower part; while anteriorly, the sides meet to form what is termed the bridge of the nose, which differs in shape in different people, and terminates by a rounded portion, which is called the lobe; beneath which are placed two apertures, termed the nostrils.

The upper part of the nose is completely fixed, and the bones entirely belong to it, which may be considered as containing the true organ of smell; while the lower part is perfectly moveable, capable of great dilatation and contraction; and although belonging to and assisting in the function of smell, is to be considered as more important as a respiratory organ.

Besides the bones, skin, muscles, cartilage, fibro-cartilage, and mucous membrane, enter into the composition of this organ.

Of the skin.—Little or no difference is observable between the skin covering the nose and the rest of the face, excepting that it is not covered with hair. It is connected to the subjacent parts by a delicate cellular membrane, which never secretes adeps, but unites it with different degrees of firmness in different parts of the nose; for instance, more firmly in the mesian line of the bridge, and with the alæ, than in the other parts. The skin is furnished with a number of small follicles, which secrete a sebaceous fluid, more especially in the groove attaching the alæ to the cheeks. These follicles open into a small oval sac, from which their secretion may be pressed somewhat in the form of a little worm.

The *muscles* of the nose—have already been described with the muscles of the face. *Vide* Vol. II. p. 69, *et seq.*

The *cartilages*—are three in number, namely, a middle one, forming a cartilaginous septum, and the two lateral.

The cartilage of the septum, is triangular in its form, and vertically placed, being connected above with the nasal process of the ethmoid bone, behind and below with the anterior edge of the vomer, which has a deep groove to receive it; while anteriorly, it is placed between and connected with the two lateral cartilages of the nose, and with the fibro-cartilages which form the boundaries to the nasal openings. It is to the anterior edge of this septum that the two *lateral cartilages* are connected; and from which they pass to be attached to the nasal, and to the anterior edge of the nasal processes of the superior maxillary bones. They are triangular in their form, are covered externally by the compressores narium muscles; and internally they are lined by the pituitary membrane.

The *fibro-cartilages* of the nose—produce the apertures of the nostrils, as well as the alæ. Those of the opening are very irregular in their form, but are curved upon themselves, so as to produce an inner and an outer crus; the inner curved forwards, and uniting to be connected by ligament with the cartilaginous septum, assist in forming a septum between the two nostrils; while the posterior crura pass backwards to be connected with the fibro-cartilages of the alæ; they thus produce apertures of an elleptical form, which are influenced by the muscles of the upper lip, and by the compressores narium.

The fibro-cartilages of the alæ, are also very irregular in their form, are inconsiderable in size, and are connected with the preceding fibro-cartilages, and with the lateral cartilages of the nose. They seem to be for the purpose of keeping the nostrils constantly open, without the necessity of muscular exertion.

All these parts, as well as the osseous structures before described, are lined by a continuation of the gastro-pulmonary mucous membrane, usually termed either the Schneiderian, or the pituitary membrane.

The *pituitary membrane*—lines the whole of the internal parts of the nose, being continuous at the edges of the nostrils with the common integuments of the face, above with the continuation of the tunica conjunctiva, and behind with the mucous membrane lining the eustachian tubes, pharynx, and larynx. Within the nose, it forms numerous folds and duplicatures, corresponding with all the irregularities of the internal surface of this organ; presenting therefore a very extended secreting surface. To trace it from its commencement at the nasal fossæ, through all its intricate folds, would only be to reiterate the irregularities on the surfaces of the bones which have already been described. It presents through its whole course, an external surface, which is connected with the bones of the nose; while its internal surface presents a spongy red appearance, with distinct villosities, furnished with small follicular openings. The color of the pituitary membrane, is not the same throughout its whole course, being lighter as it approaches the nostrils near which part small hairs, called vibrissæ, may be observed, and are supposed to be for the purpose of preventing foreign substances passing into the nose.

The pituitary membrane which lines the different sinuses opening into the chambers, does not seem to be furnished with follicles, and is of a much whiter color than in the nose. The secretion from this membrane constantly covers its surface; it is a viscid mucilaginous substance, but little soluble in water, and of a slightly salt taste. It is secreted more abundantly by those parts of the membrane which is least covered by epidermis; the quantity secreted varies from different circumstances, and is superabundant from the influence of cold.

The blood which supplies the nose, is conveyed by three or four ramusculi from the ramulus a. maxillaris internus, and also from the ramulus a. ophthalmicus of the internal carotid artery.

The nose receives its nervous influence from the first pair, or olfactory, from which it derives its perception of smell, from the first and second divisions of the fifth pair of nerves, and from Meckel's ganglion.

Its absorbent vessels, pass principally to the glands situated about the internal jugular vein.

Practical Remarks.

The nose, from the various structures which enter into its composition, and from the different functions which it assists in performing, is rendered peculiarly subject to disease. Perhaps among the most destructive to it, are the diseases of its bones, which, from their extreme delicacy, become quickly destroyed, and leave an irreparable deformity. Hence the necessity of the earliest attention to the first symptoms indicating these maladies, which are so frequently found to follow an injudicious use of mercury, and are considered as syphilitic, when indeed they are only mercurial. Still, however, small doses of mercury must be exhibited; and I have usually found the red oxyd, combined with opium, as the best form of mercury in these cases.

The fibro-cartilages and cartilages of the nose, are not unfrequently the subject of diseases; and from the little degree of vitality these structures possess, they have a great tendency to slough, and produce the most distressing consequences. This disease is usually considered of a specific character, and is termed lupus or noli me tangere; but as far as my experience goes, I am more inclined to attribute the ravages produced, to the peculiarity of the structures affected, and the particular functions they have to perform keeping them in constant motion, than to any specific diseased action.

Polypi very frequently form within the cavities of the nose, and when pendulous, they should be early removed, taking care in the operation to use as little violence as possible; remembering, any injury to the delicate bones to which they are attached, may lead to their destruction. Constitutional means, such as alterative and tonic medicines, are to be administered after the removal of the polypus, to prevent its recurrence.

In diseases of the antrum, the nose may become secondarily affected; and indeed, the diagnosis may be difficult; but upon examination of the nose, and finding it free from disease, while at the same time there is a fœtid smell, and a discharge of unhealthy mucus or perhaps pus, the surgeon's attention should be directed to the antrum; and usually, by striking the second molar tooth with any metallic instrument, a pain shooting into the superior maxillary bone, will indicate the seat of the disorder.

Physiology of the Sense of Smell.

This sense consists of the perception of odorous particles, emanating from bodies which are termed odoriferous, and which, being given off in all directions, are by the air conveyed into the nose in the act of respiration, and then impressing the sentient extremities of the olfactory nerve convey to the brain the peculiar sense termed smell. The sensorium receiving this impression, if pleasurably affected may particularly exert the organ of smell for a more perfect sensation; and by the will, the moveable parts of the nose are arranged in such a manner as to draw the air more forcibly into the nostrils, so that the odorous particles may not only be more abundant, but be forced upwards into the superior meatus, where the olfactory nerve is distributed: hence it is, that the snufftaker draws down the upper lip to narrow the passages and force the powder into contact with the olfactory nerve. It may be observed, that odorous particles emanate from a great variety of bodies, from some constantly, and in great abundance; and yet these particles are so infinitely minute, that no sensible diminution of weight occurs, although the odoriferous body may have given off its scent for many years.

The circumstances which occasion the odoriferous particles of bodies to be given off, as well as the nature of the particles themselves, are but little understood; it is not however to all bodies that this property belongs, and those in which no scent is perceptible, are termed inodorous.

Some physiologists have attempted to classify odours; but little seems to have been effected in such an arrangement, beyond the natural expressions of weak and strong, agreeable and disagreeable:—distinctions which, however, will vary as frequently as the capricious fancies of different individuals. It has been asserted, that some odours possess poisonous properties; but there is some doubt, whether or not these effects are attributable to absorption, either in the lungs or in the stomach; whether they may have been conveyed by respiration to the former, or by deglution to the latter. The atmosphere is the general medium by which odorous particles are transported; but they are also said to be given off with considerable force in vacuo; and it has been conjectured, that they obey laws of reflection similar to light. Little, however, is yet known upon this subject. Odours combine with various substances, both liquid and solid; and in this way are preserved for a considerable length of time. When an odoriferous body is applied to the nose, its odorous particles are drawn up upon the extended surface of the Schneiderian membrane, and there mingle with its mucous secretion, which may be rendered more abundant if the odour be too powerful, so as to dilute them, or by entangling them, assist in retaining the weaker impressions. For this purpose, the membrane lining the upper meatus secretes the mucous in the greatest quantity, the cells being most capacious, and the nerves most abundantly distributed.

LECTURE XXXIX.

DESCRIPTIVE ANATOMY OF THE ORGAN OF TASTE.

The mouth might have been described when speaking of the organs of digestion; but as it is so particularly connected with the function of taste, and the salivary apparatus, it may perhaps be as properly considered now, as with the function of deglutition. The bones which enter into its composition, have already been described (p. 74, Vol. I.); but the lips, cheeks, gums, palate, tonsils, salivary glands, and tongue, all concur in the performance of the function of taste, and many of them assist in other functions.

The *mouth*—is placed between the two jaws, below the nasal fossæ, and in front of the pharynx; it presents an oval cavity, which opens anteriorly by an horizontal aperture, capable however of considerable variety of figure from the muscles of the lips.

The interior of this cavity is lined by a mucous membrane, which, commencing from the cutaneous edge of each lip, passes to the anterior surface of either jaw, covering the gums, and forming in the mesian line a frenum to each lip. It then passes over the gums, dips down into the alveolar processes, thus enclosing the roots of the teeth; which circumstance has led some physiologists to describe the teeth as products of the mucous membrane; from the alveolar processes, both above and below, it proceeds into the cavity of the mouth; above covering the palate, below the muscles of the tongue and the tongue itself, forming a frenum for that organ to unite it with the symphysis of the lower jaw. It then proceeds backwards, surrounding the pillars of the fauces, covering the tonsils, and terminates by being connected with the mucous membrane of the pharynx, larynx, and eustachian tubes. In its course, however, it enters into the excretory ducts of all the glandular and follicular apparatus opening into the mouth.

The *lips*—form the anterior parietes to the mouth, and are connected with the upper and lower jaw, from which they are respectively named. Laterally, they are connected with the cheeks, where they meet, forming their commissure; they each present an attached edge to their respective jaws, and a free edge, which come in contact with each other, are covered by mucous membrane, and form the anterior opening of the mouth. Their free edges can be so perfectly approximated, that all the power of the muscles of expiration is incapable of forcing air between them, although there appears to be but little muscular power used in their approximation. The external surface of each lip is covered with skin, which, after the age of puberty, in the male, is furnished with hair, forming a large portion of the beard. The internal surface is lined by mucous membrane, which in the mesian line forms a frenum to each lip. Between the skin and the mucous membrane, the muscles of the lips are placed, which have been described (*vide* p. 71, *et seq.* Vol. II.); and between the muscles and the mucous membrane, there are numerous follicular sacs, which are termed the labial glands, and which have their excretory ducts opening into the interior of the mouth.

The lips are supplied with blood by ramusculi from the facial ramuli of the external carotid; and the blood is returned by corresponding venous ramuli, into the internal jugular vein.

Their nervous influence, is derived from the second and third divisions of the fifth pair, and from the facial nerve.

Their absorbents, terminate in the glands situated under the chin.

The *cheeks*—which form the lateral boundaries to the mouth, are composed of skin, a layer of adeps, muscles, mucous membrane, and the excretory duct of the parotid gland. There is but little to observe with respect to them; the quantity of fat which they contain, gives a general contour to the face; the muscles which particularly enter into their composition, are the buccinatores—by the action of which, they assist in the function of mastication and deglutition; and by pressing the saliva from the ducts of the parotid glands, they perform, in part, the function of taste; and farther, by forcing and directing the air through the mouth, the cheeks become important organs in respiration and voice: but these muscles have been particularly described, as in the above reference.

Some mucous follicles are also placed between the muscles of the cheeks and mucous membrane, which are termed the buccal glands.

The cheeks are supplied with blood, by the facial and internal maxillary ramuli of the external carotid ramus, and the venous branches accompanying the arterial, terminate partly in the internal, and partly in the external jugular vein.

Their absorbents, pass to the glands of the neck, and in an absorbent gland generally situated on the parotid.

The roof of the mouth, or bony palate, as well as the alveolar processes of the two jaws, are covered by a peculiar structure, which is termed the—

Soft palate, and gums.—They seem to be a thickening of the common mucous membrane of the mouth, connected by a very dense cellular tissue to the periosteum of the bones to which they are attached. The structure is but little sensible, forming therefore a protection to the osseous parts of the mouth; and being covered by the mucous membrane, it affords a continuous secreting mucous surface.

The gums, which are composed of the same firm compact tissue, which covers the palate, surround the necks of the teeth, and fill the intervals between them, so as to protect all their bony parts which are not covered by enamel.

The soft palate, as well as the gums, receive blood-vessels and nerves; but their degree of sensibility is very slight in a healthy state, although in disease they become highly painful.

The arterial distribution to the palate and gums, proceeds from the ramifications of the external carotid ramus, and principally from its facial and internal maxillary ramuli.

The nervous distributions, are derived from the second and third divisions of the fifth pair, and from Meckel's ganglion.

The *tonsils*—are placed one on either side of the fauces, between the pillars; they are about the size of an almond, somewhat of that shape, and are placed with their larger extremity upwards, towards the junction of the two pillars of the fauces with the velum pendulum palati; and their smaller extremity points downwards, resting upon the tongue; externally, they are bounded by the superior constrictor of the pharynx; anteriorly, by the constrictor isthmi faucium; and internally, they are directed towards each other.

The tonsil seems to be made up of a number of mucous follicular sacs, united to each other by a firm, dense, cellular tissue, covered by the mucous membrane of the mouth. If a section be made of the tonsil, it presents a honey-comb appearance, from the numerous cells which are laid open, and which are larger nearer their upper than their lower extremities. All these cells are lined by the mucous membrane of the mouth, which enters them by their excretory ducts.

Ramusculi from the lingual, facial, and internal maxillary ramuli, send blood to the tonsils.

The nervous filaments, are supplied by the lingual, and glosso-pharyngeal nerves.

The *tongue*—has already been partly described by the anatomical account of its muscles, as far as refers to it as an organ of deglutition (*vide* p. 91, Vol. II.); but we have now to consider it as the principal organ of taste.

The tongue is placed within the cavity of the mouth, behind the teeth, in front of the epiglottis, above the os hyoides and the pharynx, and below the arch of the palate: it is divided into its body, base, and apex.

The *body*—presents a superior and an inferior surface, and two edges.

The *superior surface,* or *dorsum* of the tongue—presents in its centre a longitudinal furrow, which divides it into symmetrical halves, and which terminates posteriorly in the *foramen cæcum*—an opening of mucous follicles.

The *inferior surface* — is smooth anteriorly, free, and covered by the mucous membrane of the mouth; which membrane posteriorly connects the tongue to the os hyoides, and parts below—producing what is termed the *frænum linguæ.*

The *lateral edges*—are rounded, thicker posteriorly than anteriorly, are fixed behind, by the mucous membrane and muscles, to the lower jaw, and styloid processes of the temporal bones.

The *base*—is the fixed point, is the thickest and broadest part of the tongue, and is united to the os hyoides, epiglottis, and pillars of the fauces, by muscles and mucous membrane.

The *apex*—is free and rounded, and capable of the greatest mobility from the numerous muscles which form the tongue.

The tongue is composed of muscles, which have been described; and also of the mucous membrane of the mouth, which on the tongue bears great resemblance to the common integuments—being covered by a thin epidermis, and furnished with numerous follicles, forming what are termed the *papillæ.* These are divided into three sets.

The *papillæ capitatæ, vel lenticulares*—are usually from nine to fifteen in number, presenting a rounded head, connected with the tongue by a narrow neck. They are placed on the posterior part of the dorsum, and are so arranged as to commence from the foramen cæcum; from thence they pass forwards in two diverging lines, so as to present the appearance of the letter V, with the angle directed backwards.

The *papillæ fungiformes, vel semi-lenticulares*—are much smaller than the former, but much more numerous; they present small round eminences, and are dispersed over the whole surface of the tongue, but are most developed on the edges; they are separated by slight intervals from each other.

The *papillæ conicæ*—are very numerous, like the preceding, occupy a great part of the superior surface of the tongue, but are most numerous towards its apex, although those placed posteriorly are the larger. These papillæ are supposed to be supplied by, if not formed of, the termination of the gustatory nerve.

The tongue receives nervous influence from the hypoglossal nerve, which supplies its muscles, and imparts to it voluntary motion for the purposes of deglutition, speech, &c.; from the third division of the fifth pair, which is supposed to form the true organ of taste; and from the glosso-pharyngeal, which is supposed to impart to it functions sympathetic, with the respiratory organs.

Of the Salivary Glands.

There are three pair of glands, which are constantly pouring their secretion into the cavity of the mouth, and which may be considered, perhaps, equally important to the function of digestion, as to taste; but as no substance can produce any sapid sensation without being dissolved in this fluid, they may be properly enough considered with those organs, which are excited in the function of taste.

The pancreas has sometimes been considered as one of the salivary glands, and there are many circumstances in which they are very similar; as for instance, the disposition of their lobules, the absence of every distinct capsule, the mode of distribution of their blood-vessels, and the strong resemblance of their secretion: but the different situation of the pancreas, and its close connection with the digestive organs, seems to indicate the propriety of describing it, as I have done, with the chylopoietic viscera.

The *salivary glands*—are the parotid, the sub-maxillary, and the sub-lingual, more or less connected with each other, and extending from the temporo-maxillary articulation on either side to the symphysis of the lower jaw, where they in some measure unite.

The *parotid*—is the largest of the salivary glands; one is placed on either side of the head, reaching from the zygomatic process to the angle of the lower jaw, behind the posterior edge of its ascending plate, between it and the mastoid process of the temporal bone. It is somewhat pyramidal in its form, its sides being flattened, and its largest extremity placed above; it is bounded externally, by the platysma myoides muscle, and the skin of the face; internally, by the temporo-maxillary articulation, ascending plate of the lower jaw, masseter, and pterygoideus internus muscles; and behind, it is opposed to, and by condensed cellular membrane, connected with, the fossa parotidea, and auditory process of the temporal bone, the anterior edge of the sterno-cleido mastoideus, and the posterior belly of the digastricus; and below, with the styloid process of the temporal bone, to which it is firmly united by the deep cervical fascia.

The parotid gland is composed of numerous small lobules, united to each other by a condensed cellular membrane, so as to form small lobes, producing a conglomerate gland, of a greyish yellow color, firm in its texture, and not enclosed in a distinct capsule. In each of its granules, or lobules, a distinct ramusculus of an artery passes, a ramusculus of a vein commences, and a little excretory duct is given off which soon unites with the duct of another lobule, and this duct again with a third, and so on, until they all form one great duct, which passes out of the anterior edge of the gland to open into the mouth.

The parotid duct, sometimes termed Stenon's duct, is about two inches and a half to three inches long, and about a line in diameter; it leaves the outer surface of the anterior edge of the gland, and takes its course forwards, across the masseter muscle; having traversed which, it becomes embedded in a considerable quantity of adeps, and gains the buccinator; this it perforates, forming a right angle with the fibres of that muscle, and opens into the mouth through its lining mucous membrane, opposite to the second, or rather between the second and third upper molar teeth. The parotid duct is composed of two coats; an outer one, which is peculiarly firm and resisting, possessing almost a cartilaginous firmness; and an inner, thin delicate continuation of the mucous membrane of the mouth.

The arterial ramifications to the parotid gland, are derived from the temporal, posterior aural, and facial ramuli of the external carotid ramus; they are numerous, but very small, dividing again, and again, before they enter the substance of the organ.

The venous, correspond with the arterial ramifications, and terminate in the internal and external jugular veins.

It derives its nervous ramifications from the facial nerve, the third division of the fifth pair, and from the cervical plexus.

The *sub-maxillary glands.*—One is placed on either side of the upper part of the neck, immediately below the base of the lower jaw, in a triangular space, bounded above by the jaw, and below by the junction of the common tendon of the anterior and posterior bellies of the digastric muscle, to the os hyoides.

The exact position of this gland, is very difficult to understand, unless the student first considers how much its relative situation is altered according to the view which is taken of it, whether in the erect, or in the recumbent posture.

In the course of its dissection, and consequently in the recumbent posture of the subject, it would be described as being placed beneath the skin, platysma myoides, and fascia of the neck; resting upon the mylo-hyoideus muscle; bounded externally and posteriorly, by the angle of the jaw, parotid gland, and posterior belly of the digastric muscle; and anteriorly, by the hyo-glossus muscle, the hypo-glossal nerve, and the sub-lingual gland. But when described, as other parts usually are, in the erect posture of the body, then the sub-maxillary gland is placed above the platysma myoides and skin, below the mylo-hyoideus and sub-lingual gland; bounded on the outer side, by the angle of the jaw, and pterygoideus internus muscle; and on the inner, by the hyo-glossus muscle, and hypo-glossal nerve.

The *sub-maxillary gland*—is, like the parotid, composed of numerous little lobes connected by a condensed cellular membrane, and not possessing any distinct envelope. The junction of all the ducts from each lobule, produce one *excretory duct,* which emanates from the upper surface of the gland, then passes forwards and inwards upon the under surface of the hyo-glossus muscle, between the hypo-glossal and gustatory ramulus of the third division of the fifth pair; and passing between the genio hyo-glossus muscles, and sub-lingual glands, opens into the mouth, on either side of the frænum of the tongue, by a small orifice placed in the centre of a projecting tubercle. This duct, like that of the parotid, is lined by the mucous membrane of the mouth.

The sub-maxillary gland is furnished with blood by the facial, and lingual ramuli, of the external carotid.

Its venous blood passes into the internal jugular.

Its nervous ramifications, are derived from the third division of the fifth pair, and sub-maxillary ganglion.

The *sub-lingual glands*—are placed, if considered in the erect posture of the body, above the mylo-hyoidei muscles, below the genio hyo-glossi, behind the genio hyoidei, and in front of the sub-maxillary glands. In form they are somewhat lengthened from before to behind, and flattened laterally; they are organized in a similar manner to the other salivary glands, excepting that they are furnished with several excretory ducts, which in part open by the sides, and part on the frænum of the tongue.

They derive their blood from the facial, and lingual ramuli.

Their nervous influence, is derived from the third division of the fifth pair of nerves, and from the sub-maxillary ganglion.

The chemical analysis, and the properties of the saliva, have been described; *vide* p. 82, Vol. III.

Practical Remarks.

It sometimes happens, that at birth the mouth is imperforate, requiring prompt assistance, by making an horizontal incision so as to divide the two lips ; and by the application of some mechanical means, to prevent reunion of the edges of the incision, and at the same time by bringing the cheeks forward to prevent the antagonizing muscles producing too great a distention of the orbicularis oris. The upper lip is also at birth subject to a malformation, termed a hare-lip ; generally there is but one fissure, but sometimes more ; and these require a surgical operation, to remove the deformity. This disease is sometimes complicated with a fissure extending through the roof of the mouth ; if only through the palatine processes of the superior maxillary bone, the fissure will frequently close after the common operation for the hare lip ; and in such cases the operation should be performed as early as possible : but if the fissure extends through the palate bones, and soft palate, a further operation is required, to close the cavity. This may be effected by paring the edges of the fissure, and by making two longitudinal incisions, one on either side of the fissure, and at some little distance from it, so as to detach the soft palate from the bone; and then by sutures, to draw the edges of the incised portions together. In the soft palate, the edges alone require paring. In simple hare-lip, the edges of the cleft are to be pared, and the incisions are to be brought in close contact, either by sutures or pins; at the same time bringing the cheeks forwards, to prevent the action of the antagonizing muscles upon the orbicularis oris. The sutures or pins should be allowed to remain three or four days ; and when they are removed, the means employed for bringing the cheeks forwards, should still be continued, lest the action of the muscles should tear open the newly-formed cicatrix. If the deformity of the lip is not so great as to prevent the infant sucking, it is better not to perform the operation until after the child be weaned, and has learned to take its food ; but if the malformation is so great, as to prevent the child sucking, it must be performed as early as possible.

Cancer of the lip—a disease which occurs almost always in the under lip, may be known by its hardness, wart-like appearance, lancinating pain, and age of the patient—as it rarely occurs before the age of forty. Men are more liable to it than women ; and extirpation is the only cure : at the same time, administering alterative medicines, and paying great attention to every means which can be adopted for the improvement of the general health. After the disease has been removed, the edges of the wound are to be brought together, in the same manner as in hare-lip.

The tongue is not unfrequently the subject of disease, and ulcer is that of the most frequent occurrence, being often produced by the rough edge of a tooth; if this be the cause, filing the tooth, or extracting it, will prove its infallible remedy. Ulcers in the tongue, sometimes are concomitant with a deranged state of the digestive organs, producing little aphthous sores on the mucous membrane of the tongue and lips. In these cases, the ulcers should be touched with nitric acid, and blue pill, with neutral salts and bitters, used as constitutional remedies.

The tongue is also liable to malignant diseases, and cancerous ulceration is not very unfrequent. In this situation, as in other parts of the body, extirpation of the diseased part is the only hope; and when it can be effected, is to be performed in the following manner:—a needle is to be passed through the centre of the tongue, opposite to the disease, armed with two ligatures, and by this means the tongue is readily held by an assistant, which cannot in any other way be commanded; one ligature is then to be tied tightly behind, and one in front of the ulcer, including between the ligatures a sufficient portion of healthy parts, as to allow of the complete extirpation of the disease; these ligatures preclude the possibility of any alarming hæmorrhage. The exposed surface should either be touched with nitric acid or actual cautery, with the hope of inducing a new action; and the constitution should be affected by alterative, and tonic medicines. As far as my experience goes, however, this disease soon returns in the absorbent glands under the lower jaw; and five months is the longest period I have known any patient survive the extirpation of a cancerous ulcer from the tongue. The frænum of the tongue may require to be cut, for the purpose of liberating the organ when the frænum is too short, either to allow the tongue to be brought out of the mouth, or to be raised up to the palate. In performing this operation, the scissors should be directed downwards, so as to avoid the ranine artery.

The tonsils are sometimes inflamed, so much so as to interfere with deglutition and respiration. Relief may immediately be obtained, by scarifying the tonsils, and by the use of restringent lotions, and alterative medicines. The inflammation, however, sometimes goes on to form abscess, which not only produces mechanical obstruction to deglutition, but also such constitutional derangement us occurs in the formation of matter in other parts of the body. The matter should be immediately evacuated, by passing either the point of a lancet or a phymosis knife into the tonsil, directing it backwards, downwards, and inwards, so as to avoid injury to the internal carotid ramus, which is behind it and to its outer side. The extirpation of a part of the tonsil, is sometimes required, in consequence of chronic inflammation, producing such a permanent enlargement, as to interfere with deglutition and breathing.

This operation is best performed by the application of a ligature, which is applied by means of what is called a tonsil needle, and being tied tightly around the diseased part, it is to be twisted tighter every day until the included portion of the tonsil sloughs off. The tonsil needle may either be passed through the nose, or mouth, as may be found most convenient to the operator.

The uvula is not unfrequently elongated; astringent gargles are usually sufficient to effect its contraction; but it sometimes will not yield to this treatment, and requires excision; and the superfluous portion may be removed with scissors, without any fear of ill effects from hæmorrhage.

The diseases of the gums and teeth, I have intentionally omitted, as my friend and colleague Mr. Thomas Bell, not only lectures most ably, but has written a *most excellent* work upon the subject.

From ulcer or wound in the cheek, it sometimes happens, that the parotid duct, or the parotid gland itself, is injured, so that the saliva is constantly pouring upon the face, and the wound thereby prevented from being healed, soon puts on a fistulous character. If the accident be a wound of the duct,—either from any accidental cause, or perhaps from surgical operation, as removing a small tumour from the face,—the aperture should be immediately closed; and every attempt made to unite the outer wound, by a just adaptation of the parts, and desiring the patient not to masticate for a few days, so that the part may not only be kept in a perfect state of rest, but that also the salivary apparatus may not be stimulated to secretion. If the wound has been open for some time, these means will prove ineffectual, and an operation is usually necessary to produce a cure. This operation is performed in the following manner:—a needle armed with a thread is passed through the opening in the duct, directly into the mouth, and a knot being tied at the farther end of the thread, the ligature is drawn tight so as to keep a constant pressure upon the knot, and induce its ulceration into the mouth; by which means a passage is established, and the saliva no longer passes through the outer wound, which soon heals. Desault recommends as a cure for salivary fistula, such a degree of pressure upon the salivary gland, as to induce its absorption; hence, no saliva being secreted, the fistula heals, and it is found that no ill effects are produced by the diminution of the quantity of saliva secreted. I have myself, in removing a small diseased absorbent gland, wounded the parotid gland, and a quantity of saliva was immediately poured out. Considerable difficulty occurred in the reparation of this wound; but after caustic, actual cautery, and other means had failed, sprinkling the red oxyd of mercury two or three times a day upon the wound, ultimately succeeded in curing it.

The sub-maxillary and the sub-lingual ducts, are sometimes rendered impervious, either from the thickening of the lining mucous membrane, or from minute calculi obstructing them; the result of which is, great distention of their salivary ducts, producing a considerable tumour underneath the tongue: this disease is termed—

Ranula—and may be known at once by its fluctuating feel, and by its semi-transparency. It sometimes produces great difficulty of breathing, from pressing the tongue backwards so as to close the glottis. The late Mr. Cline heard a person fall in his anti-room, and running in to see what was the matter, he found a gentleman lying on the floor, with his countenance livid, and apparently struggling in the last agonies of death. Mr. Cline immediately passed his finger into the mouth, to observe what might be the cause of this asphyxia, and there discovered a large ranula, into which he directly thrust his lancet, let out the saliva, and the patient was immediately restored by the prompt application of Mr. Cline's surgical knowledge.

When the disease is recent, the contents of the tumour have perfect resemblance to the white of an egg: but they soon become more viscid, and of a darker color. Whether the tumour affects deglutition and respiration, or not, it should be laid open, as its pressure is sure to cause injury to the lower jaw. They produce but little or no pain, and are generally cured by laying the tumour open, and cutting out a portion of the sac: some surgeons further recommend a stimulating application to the inner surface of the sac, to secure adhesive inflammation. If the ranula be very small, and a small calculus the cause of the obstruction of the duct, the removal of the calculus will usually be found sufficient, without any further operation.

Physiology of Taste.

The sense of taste, informs us of the flavor or sapid qualities of bodies dissolved in saliva. Certain bodies, however, that are soluble, are yet destitute of tase; while others, apparently insoluble, have yet a distinct flavour. Hence it has been conjectured, that the chemical properties, and their peculiar connection with the animal economy, may therefore contribute to the sense of taste.

Such bodies as produce an agreeable flavour, are generally useful and nutritious; while those which are pernicious, occasion a disagreeable sensation in the mouth.

Bodies are said to be bitter or sweet, sour, acid or acrid; but like the classification of odours, no satisfactory arrangement has yet been made of sapid bodies.

The tongue, is the principal organ of taste; but it is evident, that the lips, internal surface of the cheeks, palate, pharynx, œsophagus, and even the stomach itself, are capable of receiving impressions from the contact of sapid bodies, which contribute to the perfection of this sense —the actual seat of which has so long been a matter of controversy amongst physiologists. The experiments of Guyot, detailed in the *Bibliotheque Universelle*, appear, however, to set this matter at rest. The tongue was enclosed in a case of soft parchment, which only extended from the tip to about the middle; sapid bodies then introduced, gave no taste:—proving, that the anterior extremity of the tongue was the essential organ of taste. The tongue was next covered entirely, when common bodies being introduced gave no taste; but extract of aloes, and other bodies very highly sapid, gave a slight taste at the posterior part of the tongue, corresponding to the velum palatum. No other sensation than that of touching was excited on the application of extract of aloes to the palate, roof of the mouth, or cheeks. It is the anterior and upper part of the velum palatum which possesses the sense, in a space, however, small and undefined in its limits.

It was further observed, that when the tongue was covered with parchment, and a hole being left in the middle of its posterior surface, that on the application of sapid bodies to this exposed portion, the sense of taste was not produced until the sapid body was dissolved in saliva, and gained access to the tip of the tongue. And Guyot found, that only certain parts, namely, within a space of about one or two lines at the sides, three or four at the tip, and within a curved space at the back, were the only seats of the organ of taste.

The saliva poured into the mouth from the salivary glands, possesses a peculiar power as a solvent; and in the act of tasting, it is evident that the operation consists in applying the tongue in such a manner as to expose its papillæ to the sapid substance mixed with the saliva. Mere contact, however, may be sufficient for fluid, or gasseous bodies; but solid bodies appear to require actual solution, before their flavour can be tasted.

The arrangement of the papillæ is so made, that those which distinguish flavour are protected, and as it were separated from those which secrete the mucus, lubricating the mouth, and fauces, contributing to the act of swallowing.

The papillæ conicæ—are disposed in two rows, wider at the tip and back part of the tongue, than at the sides, and are probably those destined particularly to the sense of taste

The nerves which supply the tongue, are derived from several sources; thus we have the inferior, and a few ramuli from the superior maxillary rami, filaments also from the spheno-palatine ganglion, the naso-palatine of Meckel, the lingual, and the glosso-pharyngeal nerves.

The lingual, or gustatory branch of the fifth pair, has been traced to the villi, and papillæ conicæ, and has therefore been considered as the principal nerve of the sense of taste ; but other nerves may also contribute, although they cannot be traced distinctly.

Majendie asserts, that on the division of the lingual gustatory nerve, the tongue continues the power of motion, but loses the sense of flavour; but the palate, gums, and internal surface of the cheeks, preserve their aptitude for the exercise of taste: but if the trunk of the fifth pair be divided in the cranium, then the property of recognising flavours is completely lost. The same occurs in diseases affecting the fifth pair.

When sapid bodies are brought into contact with the mucous surface of the tongue, such as vinegar, mineral acids, alkalies, and many others, the color of the membrane has been observed to change—becoming sometimes white, at others yellow: from whence it has been conjectured, that some chemical change has been effected, and that the durability of an impression depends upon their changes. For instance:—acrid bodies leave an after-impression in the pharynx; acids, on the lips, and teeth ; peppermint, through the mouth and pharynx. These impressions obtain a wonderful degree of delicacy and accuracy, by exercise and habit of the parts, as may be evinced by those who have exercised it in distinguishing the flavour of wines. In old persons, this sense becomes weak, and requires stimulating things to excite it: it appears, also, that young infants do not fully acquire the sense of taste, until some time after they are born; they however possess it at birth, as may be seen by placing a bitter or saline substance on the lips.

Taste presides over the choice of food, and enables us to distinguish between wholesome and noxious substances; and when exercised with agreeable food, is a source of considerable pleasure, but which, if too much indulged, will form an epicure, whose wants are an evident abuse of this sense.

FINIS.

Fig.1.

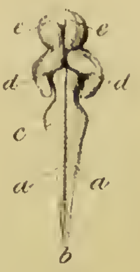


Fig.2.

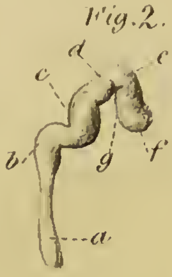


Fig.4.

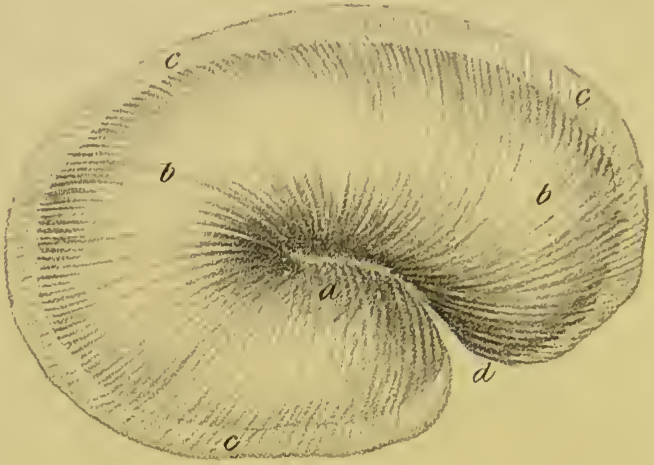


Fig 3

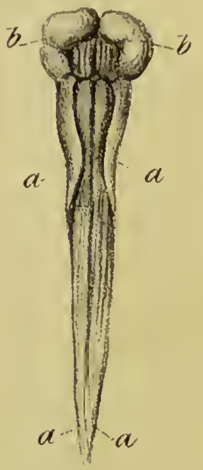
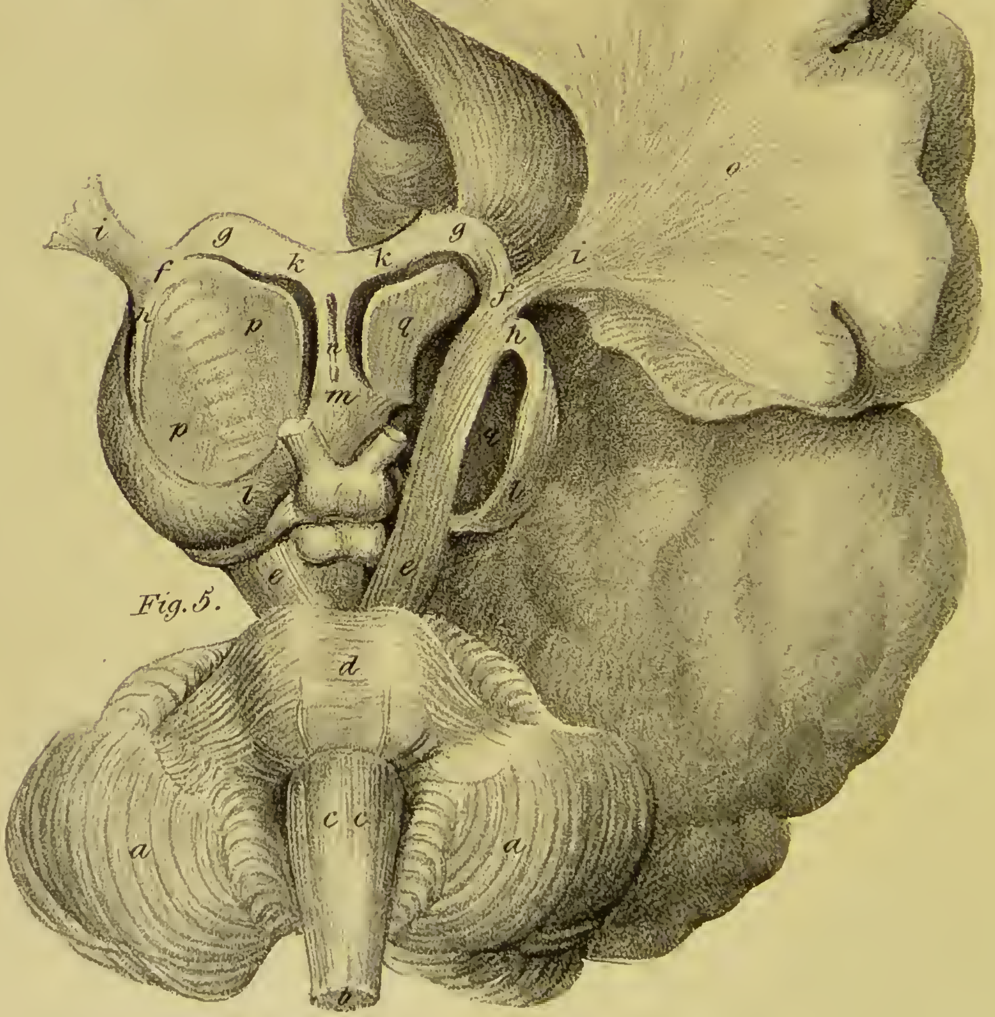


Fig.5.



S. Warr Lith: H I S. Fecit.

EXPLANATION OF THE PLATES.

PLATE I.

Fig. 1.

The earliest appearance of the brain and spinal marrow twice the natural size. From a fœtus of seven weeks. Viewed anteriorly.

a. a. Spinal marrow.
b. Orifice of the canal of the spinal marrow.
c. Enlargement of the spinal marrow.
d. d. Cerebellum, extended like a bridge over the fourth ventricle.
e. e. The tubercula quadrigemina, separated by a middle line.

Fig. 2.

Side-view of Fig. 1.

a. Spinal marrow.
b. Enlargement of the spinal marrow, with its inflection forwards.
c. Cerebellum.
d. Mass of the tubercula quadrigemina.
e. Optic chambers.
f. Membranous hemispheres of the brain.
g. Protuberance analogous to the corpus striatum.

Fig 3.

a. a. a. a. Two principal cords of the spinal marrow, separated to shew the continuity of the canal with the fourth ventricle.
b. b. Peduncles of the cerebellum inclined towards each other.

Fig. 4.

Radiation of the fibres as they proceed from the crus cerebri, as seen in a fœtal brain of six months.

a.	Point of radiation.
b. b.	Radiating fibres.
c. c. c.	Softer fibres exterior to them.
d.	Fissure of Sylvius.

Fig. 5.

View of the under surface of the brain, according to the mode of dissection adopted by Dr. Foville.

a. a.	The cerebellum.
b.	The medulla oblongata.
c. c.	The corpora pyramidalia.
d.	The pons varolii.
e. e.	Continuation of the corpora pyramidalia through the pons varolii to the crura cerebri.
f. f.	The point at which the corpora pyramidalia divide into three layers, or plates, just at the outer side of the corpora striata.
g.	The ascending plate.
h.	The descending plate.
i.	The external plate.
k. k.	The ascending plates, one from either side uniting to form the corpus callosum.
l. l.	The descending plates, uniting in the mesian line to form the septum lucidum, *m.*
n.	The fifth ventricle between the two layers of the septum lucidum.
o. o.	The fibres of the external plate diverging to form the hemispheres of the cerebrum.
p. p.	Section of the corpus striatum of the right side, shewing the fibres of the corpus pyramidale passing through it to the point at *f.*
q. q.	Section of the corpus striatum of the left side, the continuation of the corpus pyramidale being left entire.

Pl. 2.

Fig. 1.

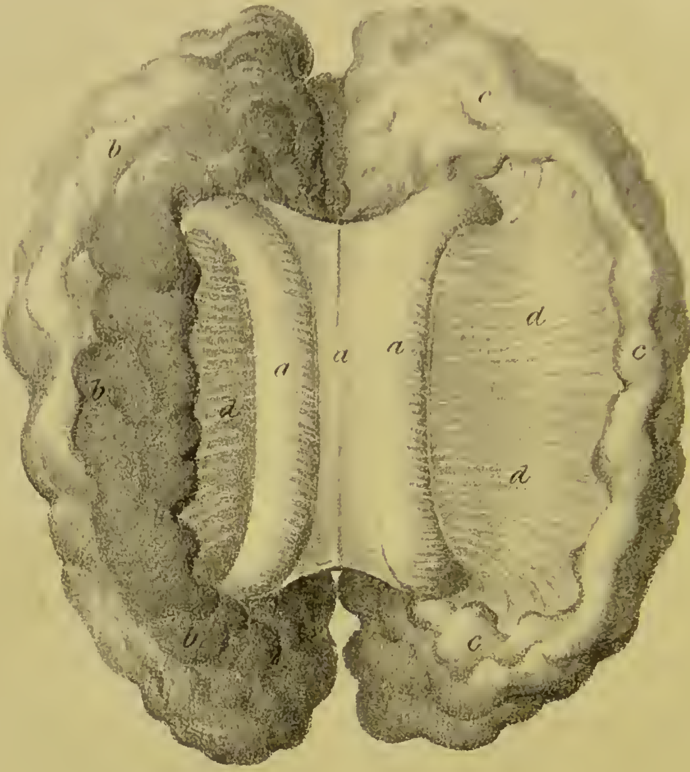


Fig. 2.

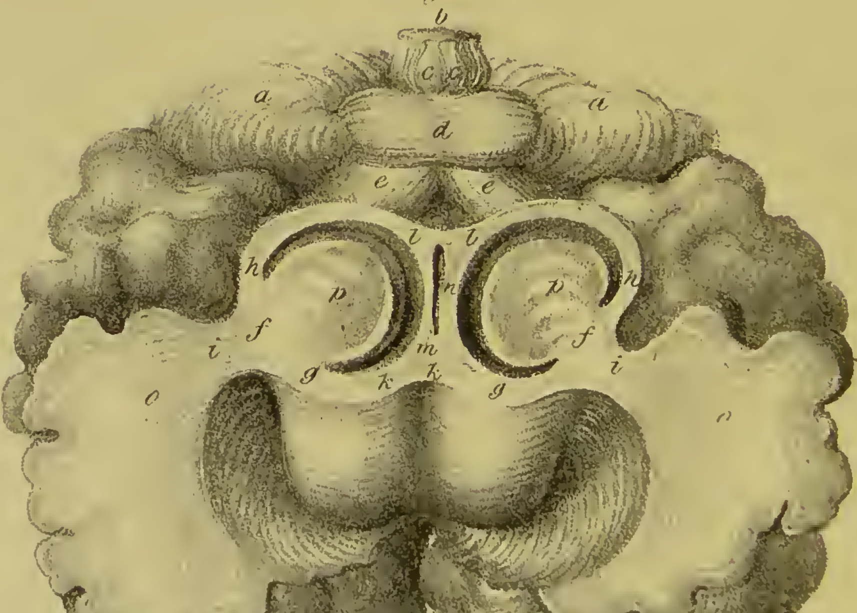


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PLATE II.

Fig. 1.

The upper surface of the brain, the hemispheres being separated.

a. a. a.	The corpus callosum, having the raphe in its centre.
b. b. b.	The left hemisphere, but slightly separated.
c. c. c.	The right hemisphere, separated to its fullest extent.
d. d. d.	The diverging fibres of the external plate.

Fig. 2.

Front view of a transverse section of the brain, opposite to the coronal suture. The under surface being shortened, and placed uppermost, to exemplify more perfectly the three plates of the corpora pyramidalia.

The references the same as to Fig. 5. Plate I.

Fig. 1.

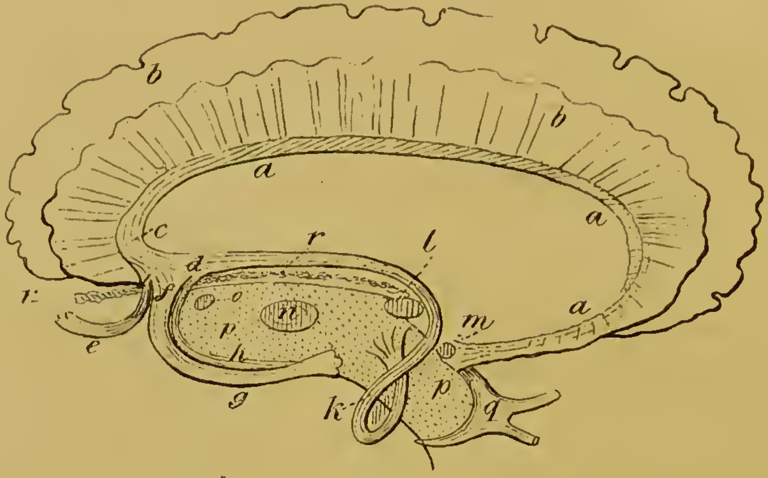

Fig. 2.

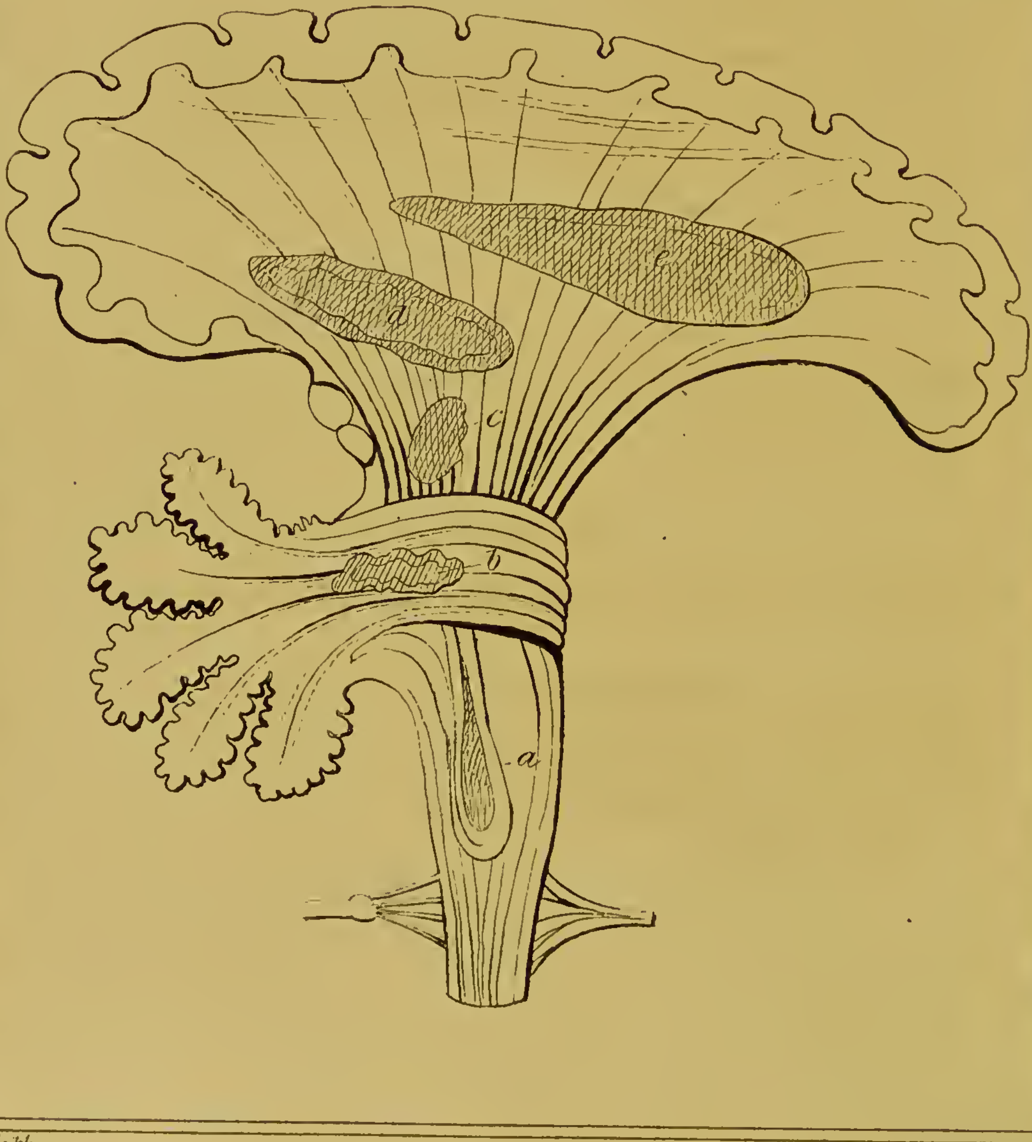

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PLATE III.

Fig. 1.

Diagram of a side-view of the same dissection, produced by a vertical section from the centre of the corpus callosum to the base of the brain.

a. a. a. Corpus callosum.
b. b. Hemisphere.
c. Point at which the corpus callosum unites with the fornix.
d. The fornix.
e. Hippocampus minor.
f. Hippocampus major.
g. Pes hippocampus.
h. Tænia hippocampus, or posterior crus of the fornix.
i. Anterior crus of the fornix.
k. The processus mammillaris.
l. Foramen of Monro.
m. Anterior commissure.
n. Middle commissure.
o. Posterior commissure.
p. p. Thalamus nervi optici.
q. Optic nerves.
r. r. Plexus choroides.

Fig. 2.

Diagram, in which the situation of the ganglia of Drs. Gall and Spurzheim are seen.

a. Grey matter in the corpus olivare.
b. Grey matter in the pons varolii.
c. Grey matter in the crus cerebelli.
d. Grey matter in the thalami nervi optici.
e. Corpus striatum.

Fig 1.

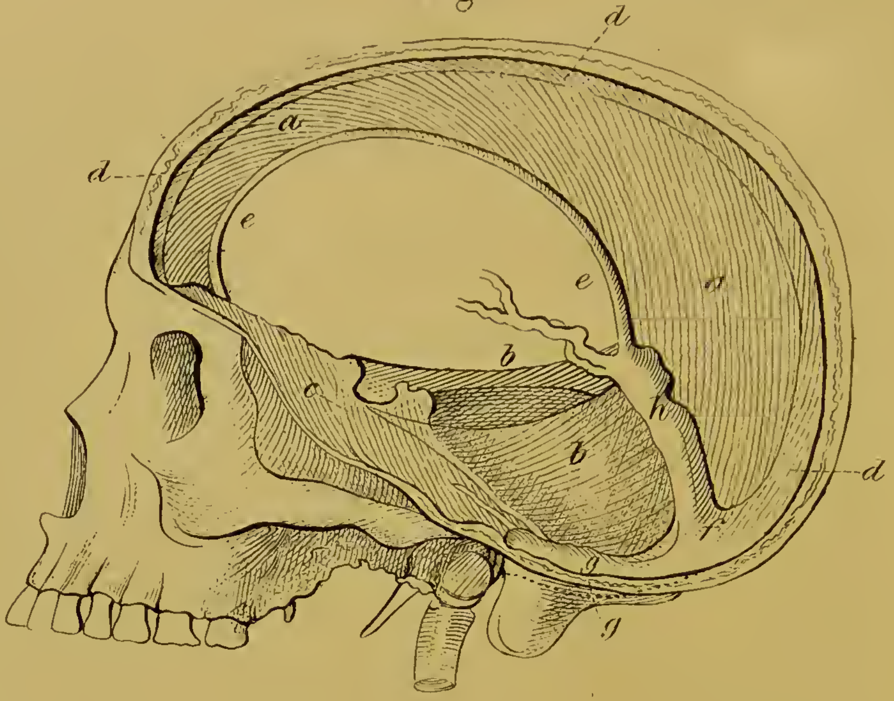

Fig 2.

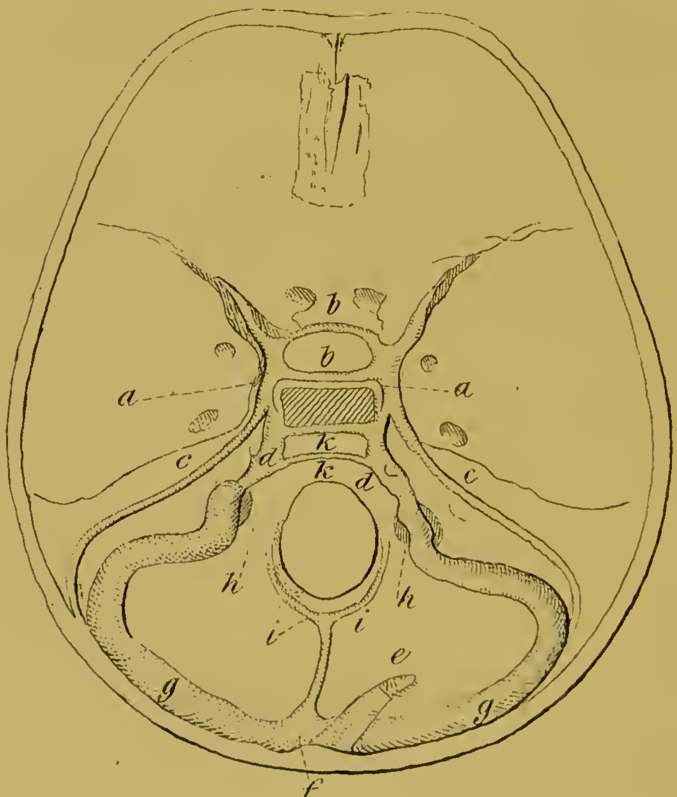

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PLATE IV.

Fig. 1.

The processes and sinuses of the dura mater.

a. a.	The falx major.
b. b.	The tentorium.
c.	Sphenoidal fold, left side.
d. d. d.	Superior longitudinal sinus.
e. e.	Inferior longitudinal sinus.
f.	Torcular herophili.
g.	Lateral sinus.
h.	Straight sinus.
i.	Vena magna Galeni.

Fig. 2.

Sinuses in the internal part of the basis of the cranium.

a. a.	Cavernous sinuses.
b. b.	Circular sinuses.
c. c.	Superior petrosal sinuses.
d. d.	Inferior petrosal sinuses.
e.	Superior longitudinal sinus.
f.	Torcular herophili.
g. g.	Lateral sinuses.
h. h.	Foramina lacera basis cranii.
i. i.	Posterior occipital sinuses.
k. k.	Anterior occipital sinuses.

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